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CONTENTS

TRANSLATING SCIENCE AND TECHNOLOGY INTO SOCIAL, ECONOMIC GAIN IS GOAL OF SCIENOLOGY

Beijing ZIRAN BIANZHENGFA TONGXUN [JOURNAL OF DIALECTICS OF NATURE] in Chinese Vol 4, No 3, 10 Jun 82 pp 31-36

[Article*by Li Chang [2621 2490]: "The Present Task of Our Nation's Research in Science of Science"]

[Text] The science of science [also referred to as "scienology"], as a new field of science, has developed very rapidly abroad. It has also been noticed by various domestic circles in recent years. This is because modern science and technology have demonstrated a great force in creating wealth, thus people have taken science as an object of study to provide a theoretical basis and methods for management and decision making in scientific research and to guarantee the smooth development of scientific and technological endeavors. Since 1979, our nation has already held two national academic discussion conferences on the science of science. Now, we are holding a special topics discussion meeting on the science of science to explore the subjects of research in science of science and to discuss the characteristics and trends in the development of modern science and technology. I have been inspired by everyone's speeches and papers at the meeting. I shall talk about my personal views on some questions in the science of science.

I. We Need a Unified Fundamental Concept and Clear Research Targets

The study of science of science began rather late in our nation. It is still in its initial period. For nearly 3 years, everyone has been exploring freely, a hundred schools of throught have contended, and various opinions have been expressed. It seems now that doing so during the initial stage stimulates the development of this science. But such discussions have weaknesses: 1) The fundamental concepts are not consistent; 2) the research targets are too scattered.

First let us talk about the cause and the difficulties in the inconsistency of fundamental concepts. Because comrades studying the science of sciences come from all fields, their understanding of the science of science unavoidably is tainted by their own professions. The same thing has different explanations and the fundamental concepts are inconsistent. This creates confusion in the

*This article was a speech given by the author at the 1981 Discussion Meeting on the Theory of Science of Science

discussion of problems, therefore it is difficult to clarify doubts so that research can become more profound, and this hinders the growth of this science. I hope that everyone can self-conscientiously unify some fundamental concepts during the process of discussion and make the content of the central issues consistent so that we will have a common language when discussing problems.

Having dispersed research targets is also unfavorable. In the previous period, everyone explored freely from different aspects and even tried to establish a theoretical system for each type of science of science. During the stage of creating this science in our nation, this situation is difficult to avoid, but if our research targets remain scattered for a long period, our research work may fall into a situation where individuals have penetrated deeply into the subject but many will stray and become lost. Therefore, I suggest that this conference clarify the main research targets at present to concentrate strength, to link efforts with the actual situation and to solve several questions that need to be solved urgently. At the same time, free exploration can continue.

II. The Subject of Research in Science of Science

The subject of research in science of science is science, there is no question about it, but this needs explanation. Engels said in his work "The Dialectic Method and Natural Science": "The purpose of every branch of science is to analyze the forms of motion of the single element or a series of interconnected or mutually changing forms of motion." Since science of science is a science, what forms of motion does it analyze?

As an understanding of natural phenomena and laws by man, science has its system, structure, laws of inner development, and unique methodology. Scientific achievements are the body of knowledge about the various forms of motion in nature acquired by man and they are applicable throughout the nations of the world. Science of science studies these as its subjects, and science of science intersects and coincides with the scientific viewpoint and scientific methodology of natural dialectics. There is no clear boundary between science of science and natural dialectics, this is not surprising. As one form of motion develops from another form of motion, the reflection of these forms, i.e., the various branches of sciences, naturally develop from one another. This statement by Engels is a very good explanation of this phenomenon.

On the other hand, the development of science cannot be separated from the course of social movements of man's understanding of nature. It is organically linked with the politics, military affairs, economy and culture of different nations and they mutually influence each other. Science, as a social movement, is different in each nation, and it is inseparable from the productive technology of different nations. It has its own laws of development and its special laws in each nation. Science of science also takes this as the subject of research to provide a strategy and a theoretical basis for the development of science and technology.

Therefore, science of science is a science that "serves two purposes." It studies the laws of ideological development of man's understanding of nature, it also studies the laws of social movement of man's understanding of nature. If we take the book "The Social Function of Science" by J.D. Bernal as marking

the birth of science of science, then, it can be said that science of science or the main aspect of science of science is the study of the application of science in production and the study of science as a social movement, this means it studies science and technology as a whole.

Our nation's science and technology have fallen behind during the past several hundred years because of social and historical reasons. The whole nation was liberated and a new China of socialism came about. Our nation's society underwent a tremendous leap forward and science and technology developed greatly along with politics, the economy and culture. Since the crushing of the "gang of four," especially since the Third Plenum of the Party, our nation has entered a new era of building socialist modernization. We urgently need a greater development in science and technology. Under this situation, the urgent task that we face is to explore the special laws of science and technology in our nation under the guidance of Marxism-Leninism and Mao Zedong Thought and based on the general laws of the body of scientific knowledge and the development of scientific and technological endeavors and hasten its development so that it can develop a greater function in building our nation's socialist material culture and spiritual culture.

III. Several Problems That Should Be Studied With Emphasis at Present

According to the above understanding, I believe that the study of science of science in our nation should emphasis the solution of the following problems within a definite period:

1. We should explain the important function of science and technology in social development by combining theory and practice. At our nation's National Science Conference in 1978, Comrade Deng Xiaoping affirmed that science and technology are the scientific judgment of production. In capitalist nations, this has not been a problem for a long time because of the history of several hundred years of scientific development and application. Modern science was born and developed with capitalism centered in the cities. The Western capitalist class first used science as an intellectual weapon against feudalism, and later it used science as a means to generate wealth and to conquer the world. The Western capitalist class understands the important meaning of science and technology and their economic value. The situation in China is different. Our nation's feudal society once produced a brilliant culture and advanced science and technology, but development dropped during the final stage. Up to the time before liberation, our nation was still a semi-feudal and semi-colonial society. This was different from the democratic revolution of the Western capitalist class. The center of their revolution was basically in the cities, while the center of our revolution always remained in the farm villages. Finally, the farm villages encircled the cities and the cities were liberated. Therefore, our party and people are unfamiliar with recent and modern science and technology and with intellectuals engaged in scientific and technological work. For a long time, we have not had a sufficient understanding of science and technology as a productive force. During the 10 years of sabotage by Lin Biao and the "gang of four," they concluded simply that social practice was productive practice and class struggle. They totally rejected that scientific development directly originated from scientific practice

(theoretical research and observation, experimentation) and they rejected the great social function of science and technology. They forced scientific research to stop, disbanded scientific research agencies, and criticized intellectuals and the so-called "private ownership of knowledge." They have created a disaster for our scientific endeavors. Although the national science conference corrected the rule of leftist mistakes over our nation's scientific and technological battlefront and affirmed that science and technology are productive forces, but profound understanding of this scientific judgment is still a course of hard efforts that needs to be carried out.

Because of this, in March 1981, when the Central Secretariat heard the general report on the work of the Chinese Academy of Sciences, Comrade Hu Yaobang mentioned three things: First, the understanding of the importance of science and technology by the whole party and the whole people must be improved. Second, the Central Committee must have a correct policy and guideline for science and technology; Third, scientific and technological work must make important contributions. The task of researchers in science of science, in my view, is to explain the important functions of science and technology and to explain that science and technology are productive forces by combining theory with practice, by implementing the correct policies for science and technology and by taking forceful measures to realize visible economic gain. The more profoundly we explain the importance of science and technology, the scientific judgment that science and technology are productive forces, that science is a strong weapon to promote social progress and to develop civility, the more possible it is to launch a long-lasting enthusiasm of the whole nation to love science, learn science and use science. Our science and technology will develop even faster. But the solution to this problem is not something that can be done in a short time. It would be good if the understanding of the importance of science and technology by the whole party and the whole people can be elevated to a height it should have in 3 to 5 years or in an even longer period.

2. We should profoundly study the characteristics and trends in the development of modern science and technology. Since World War II, the rapid development of science and technology has brought about great changes in economic and social development in developed nations. It is important to study the characteristics and trends of development of modern science and technology so that we can grasp the laws of development of science and technology in the world as a whole and dynamically and so that when our nation draws up a strategy for the development of science and technology, we can have a basis for its general direction and we will not make mistakes.

The characteristics of modern science and technology should be categorized according to the following: (I) The scale of scientific and technological research is becoming larger and larger while division of labor is becoming more and more refined. It has already become a national endeavor in every nation or an endeavor massively supported by each government. (II) From the end of the last century to the beginning of this century, a series of technical sciences that reflect the laws of the second nature, i.e., the nature created by man, has been formed. (III) At the beginning of this century, a revolution in physics marked by the emergence of quantum theory and relativity theory has occurred. This has opened up a new realm of human understanding of the microcosmic world and the macrocosmic world of materials. (IV) Lateral sciences

such as cybernetics and information theory and systems theory have been born. (V) The three major technologies of atomic energy, computers and space technology have emerged. (VI) Management science has formed. (VII) The revolution in life sciences and bioengineering are forming and growing. Generally speaking, modern science and technology have already reached a high level. Sixty to 70 percent of the labor productivity in developed nations during the past 10 to 20 years have relied on science and technology. The scope of activity of human understanding has penetrated the basic particles, extended to entire star systems, and touched on the nature of life. Research in robots and artificial intelligence is developing. Science and technology will discover even greater natural potential, and science and technology are demonstrating their importance in economic and social development more and more.

Such a high level of modern science and technology and such an important social function of science and technology are the results of long term development of modern science. They are also the beginning of further development of science and technology at the end of this century and in the next century. What is the trend of development of the world's science and technology? What inspirations can we get from here if we want to realize our nation's scientific and technological modernization?

First, the development of recent and modern science and technology is a process of mutual stimulation and mutual penetration. The task of science is to understand the laws of natural development. Technology is the skill and the tool for people to change nature. Technological progress helps people develop science, and scientific development promotes and generates new technologies. Since the advent of modern science represented by Newtonian mechanics, and through Britain's industrial revolution, science has been applied to mass production and new technologies have continually emerged. The birth of electromagnetism and chemistry also brought about the birth of electrical technology and chemical engineering technology, thus opening up the electrical industry and the chemical industry. The development of atomic and nuclear sciences and modern mathematics and electronics in this century brought about the birth of applied technology of atomic energy and computer technology. In recent years, following the breakthrough in life sciences, a brand new bioengineering technology has emerged. The cycle of materialization of science to become a direct productive force is becoming shorter and shorter.

Second, history shows that nations in which science is most developed are also technologically advanced and economically the most prosperous nations. But there are also nations that are technologically advanced and economically prosperous while science is not the most advanced. Britain after the Industrial Revolution, Germany at the end of the 19th century and the United States after World War II were the world's centers of science at the time and were also the technologically most advanced and economically most prosperous nations. The United States at the beginning of this century and Japan after World War II were both very advanced in production technology and were major economic nations at the time. For example, the value of industrial production of the United States in 1894 was first in the world while the gross national product of Japan at present is next only to the superpowers of the United States and the Soviet Union, ranking third in the world. There is an important conditional factor here, that is, at the time, the United States and Japan both

enjoyed political stability and the economy rose. They imported new scientific achievements and new technologies en masse. At the same time, national education was developed. There was a definite scientific and technological strength. They had rich intellectual resources sufficient to apply, digest and continually improve imported scientific achievements and new technology.

Third, the three recent and modern technological revolutions served an important function in economic and social development. The characteristic of Britain's Industrial Revolution was the production and the application of machines and steam. It was actually a technological revolution. This revolution used machines to replace manual labor and steam to replace animal power, hydraulic power and human power. This greatly improved the labor production rate and gradual mechanization of industrial and agricultural production became possible. The second technological revolution was mainly the emergence and the development of transportation and communications machines (trains, ships, automobiles, airplanes, telegraph, telephone), materials for manufacturing machines and new production methods for rubber. Electricity, petroleum and natural gas were used as new energy sources. This greatly improved transportation and communications, strengthened the link between cities and villages, shortened the distance on earth, and developed domestic and international trade. Conversely, it also promoted the further development of the world's industry and agriculture. The broad utilization of the computer and automatic control in the third technological revolution enabled material production and social life in developed nations to become more and more deeply influenced by science and technology. After the advent of the so-called industrialized society, the number of people engaged in the third sector has become larger than the total number of the people engaged in the first and the second sectors, and the 5-workday system was implemented (but capitalist nations have their internal problems, such as economic recession, inflation, mass unemployment in the United States).

Fourth, with the rapid development of modern science and technology, the economy, and society has widened the gap between developed nations and developing nations, and the development of each nation has not been balanced. Japan and Europe are catching up with the United States. Some developing nations are also trying to catch up with developed nations. This is because science and technology and the economy and society must be coordinated in order to maintain high speed development while superpowers like the United States and the Soviet Union both have even more serious limiting factors in their development. Certain developing nations are relying on the developing of human resources (labor and intellectual forces) or relying on the development of natural resources while maintaining political stability and while the government is tightly grasping economic buildup and emphasizing the development of science and technology. Their development of science and technology, economy and society is catching up in big strides.

Whether the characteristics and trends of modern science and technology described above have been analyzed and expressed correctly and clearly requires everyone to study together. Undoubtedly, the study of this topic is very important. It has a great practical significance in our buildup of the four modernizations.

3. We should study and establish long-range plans for economic and social development and develop the function of science and technology. The long range economic and social development plans in our socialist nation practicing planned economy are the blueprints for building our socialist modernization. They are the fundamental reference for establishing and implementing medium-range plans. In drawing up long-range plans, we must on the one hand consider satisfying the needs of social development that are reasonable and that are possible to realize, and on the other hand, we must consider the conditions of our nation's natural resources and the level of our nation's science and technology as a productive force. For example, our nation has a large population. By the end of this century, it will reach about 1.2 billion. Overly importing food from abroad is not possible. We must be basically self-sufficient. This requires developing the strength of science and technology to increase unit yield of currently available cultivated land and produce as much food grains as possible. At the same time we must fully utilize mountain land, grassland and water surfaces, implement the policy of macroagriculture and macrocosmic food grains, suitably change the diet of the people (more meat, eggs and dairy products and fruits). Second, as natural resources increase along with the rise in the level of science and technology, more wealth will be discovered. Kuwait is a clear example. The nation has a population of 1 million, the per capita average income reaches $25,000, ranking first in the world. I went to this country in 1966. At the time, it was still very poor. Later, it utilized foreign technology, exploited petroleum in the territorial waters, and in particular, it later nationalized the projects and nationalized the enterprises, raised the price of petroleum and became rich. We must also strengthen scientific and technological work, strengthen prospecting and the development of resources, and include these efforts in long-range and medium-range plans for economic and social development under the condition that economic gain is concretely realized.

Efforts to establish long-range plans for economic and social development must also correctly solve the problem of rational development of the economic structure and the technological structure. By the end of this century, it is hoped that per capita income will be $1,000, i.e., and the gross national product will reach $1,200 billion. The plans to multiply the two productive values must be realized in 20 years. What then should be developed as a priority? If China wants to realize the four modernizations during these 20 years, it must carry out a technological revolution. How then should the tasks that have been solved by the three technological revolutions in world history and the various types of technological structures of manual labor, mechanization, semi-mechanization, automation and semi-automation at different localities during different times (in technological structure, even including different professions, different units and different jobs) be arranged so that the maximum economic gain can be realized? All these need to be studied profoundly.

As the Central Committee has pointed out, science and technology have many branches and they should serve the various sectors. Basic research should not be weakened, and they should mainly serve economic buildup. The question is that our nation's scientific and technical teams are divided among production, the national defense industry, regional scientific research agencies, universities and the Chinese Academy of Sciences. They all mainly serve economic buildup, but we also need to profoundly study what is the proportion of basic

research, applied research, developmental work, popularization of applications, scientific and technological service in scientific research work carried out by the various sectors before the entire function of our scientific and technological battlefront can achieve the highest efficiency.

4. We should study the comprehensive utilization of science and technology to develop production. This problem is actually the problem of how to realize the four modernizations. Developed nations have gone through several hundred years of evolution. They have formed their own national scientific and technological system on their economic foundations and under their social conditions. In these nations, as science and technology are more finely divided, how science and technology form a whole and how they develop their greatest function in economic and social development are spontaneously regulated by the economic laws of capitalism. The situation in our nation is completely different. Before liberation, our nation was basically a semifeudal and semicolonial society. Science and technology were very backward. After liberation, the main portion of our nation's large industries and scientific research was introduced or learned from abroad in a parallel manner, and the two did not combine well. In addition, we implemented centralized authority and command type planned economy, and for a long time we committed leftist mistakes, unified procurement and contracted sales, eating from the big pot, not talking about economic gains, the economy lost its internal power to utilize and promote science and technology. Scientific research itself progresses in many directions simultaneously like 10,000 arrows being released together. A complete scientific and technological system that was coordinated with economic and social development did not form. Therefore, although our nation's science and technology did realize some major inventions and creations, but most were singular efforts and they could not produce a major effect upon the national economy. Therefore, although it is important that our nation's scientific and technological battlefront create new theories and new technologies, it is more important to comprehensively utilize science and technology to solve the problems of regional professions and major development in production. The Chinese Academy of Sciences and the provincial committees of Heilongjiang, Hebei, Ningxia and Hunan established five comprehensive scientific experimental bases (counties) for agricultural modernization on a trial basis. They did it this way. After 4 years of experiments, the five counties of Hailun, Luancheng, Yanci, Guyuan and Taoyuan did not invent or create any new technologies. Efforts involved only the comprehensive utilization of currently available science and technology in treating the farm village economies of the five counties as a whole. All efforts have realized achievements in stages. They summarized experience and determined the guidelines for agricultural development in the next 5 years: 1) The unit yield of agriculture, forestry, livestock production, sideline production and fishery should reach the higher levels of similar regions; 2) The per capita income should reach the advanced levels of similar regions; 3) The total value of agricultural production should increase by more than 5 percent per year (actually each province increased this by more than 6 percent); and 4) The ecological conditions should be improved, such as increasing the area of coverage by forests and grass, soil fertility should be gradually improved, the organic content in soil should be increased year after year. We believe these can be achieved. These cases explain the great potential of comprehensive utilization of science and technology. I believe this serves a

definite function in indicating to us how we should realize the four modernizations. This point is worth continued study.

IV. We Should Further Develop the Study of Science of Science

At present, the science of science has just begun in our nation. There should not be too many branches. I believe it should mainly learn and digest the achievements of foreign research in the science of science, clarify how we can hasten the development of our nation's science and technology and how we can better develop the function of science and technology in stimulating economic and social development. We must build a science of science possessing our nation's unique characteristics in the theoretical research and application of science of science. For this, I feel we should grasp tightly the following aspects of work:

1. We should develop basic research and applied research in the science of science. This means we should first study the history of development of recent and modern science and technology and foreign science of science, grasp the general laws of scientific and technological development, i.e., the laws of human understanding of nature and the laws of man's understanding of nature as a social movement. This can be said to be basic research. Then, we should study clearly the special laws of science and technology in China's development. The latter can also be said to be a kind of applied research. Without an overall understanding and an understanding of the history of science and technology without an in depth exploration of the general laws of scientific and technological development and the special laws in China, then when we encounter problems in scientific and technological development, we will handle the situation as it comes and this will never solve the problems. Without theory, this field of science of science cannot be developed.

To divide the work, to realize cooperation and to study science of science in depth, some comrades have already separately studied scientific policy, scientific and research management, scientific economics, scientific manpower and theoretical science of science, and they have already held an academic meeting on special topics. I believe that better results will be achieved if such efforts develop and persist.

2. We should form a research team. Scientific practice is the foundation for the emergence and the development of science of science. Abroad, there are many people engaged in research in the science of science. They have joined the profession after conducting research in natural sciences, the history of science, philosophy, economics, sociology and scientific research management. Our research team in science of science is the same. This specialized team is still forming at present and there are few people. But the leaders at each level are emphasizing the function of science and technology and will surely support the development of science of science. Because science of science is the theoretical explanation of the creative labor of the broad numbers of scientific and technical personnel, they will love and protect and nurture science of science. From the broad number of scientific and technical personnel will emerge many activists in science of science and semiprofessional and professional researchers. We must rely on the higher leadership and the

activists among the broad number of scientific and technical personnel to push forward the development of our nation's science of science.

3. We must tightly grasp the data and information of science of science and their publication work.

The final goal of research in the science of science is to develop science and technology. But it directly studies the laws of thought in man's understanding of nature and the laws of the social movement of man's understanding of nature. Its research method is basically the same as that of social sciences. It does not need laboratories but the indispensable data, information and libraries that are the basic raw materials for research in science of science. We now have briefs, special publications and special newspaper columns, but we lack specialized data, information, histories of foreign science, Chinese translations of famous works on the science of science and such works written by Chinese. We must conscientiously and concretely do this work. This is a basic condition for carrying out research in our science of science.

4. We must strengthen international academic exchange.

We must actively participate in international academic activities and absorb foreign research achievements to hasten the development of our research work. Exchange is reciprocal. Only if we ourselves reach a definite level and carry out exchanges will we be noted by foreign friends and be able to exchange findings in depth. We cannot just go and listen, we must use our work to meet friends and to make friends with foreign scholars in the same field. For this, we must grasp foreign languages. Relying on translations to conduct academic exchange will not work.

5. We must insist on the guidance of Marxism-Leninism and Mao Zedong Thought. We have now entered the internal arena of science and technology. Our nation is implementing the open door policy. The lifestyle and the corrupt ideology of capitalism have brought about a definite influence in our nation. In international cooperation in science of science and other sciences and technology, we must realize that our friends are all over the world. There are many foreign colleagues who are friendly to our people and who truly want to support our buildup of the four modernizations. But on the other hand, we must also see the corrupt functions of capitalist politics, economics and culture and there are even traps awaiting people who have lost political alertness. We must be armed with Marxism-Leninism and Mao Zedong Thought, love our socialist motherland, insist on sacrificing ourselves for the people's science, talk about scientific morality, establish a good scholarly atmosphere, and be proud sons and daughters of the Chinese nationality.

Science of science is a comprehensive science. It includes the content of natural sciences and the content of social sciences. The basic viewpoints of dialectic materialism and historical materialism must be the guiding thoughts and the foundation of methodology in our research work. I believe the Chinese Academy of Sciences has two unique characteristics. One is that it seeks truth from facts and serves the buildup of socialist modernization. The other is that it takes Marxist ideology as the guide. During this new era of building socialist modernization, as the economy is readjusted, reformed, reorganized and

improved, science and technology will develop their important function more and more. This is the glorious and actual situation. After the Sixth Plenum of the party, our party's Central Committee has completed the task of bringing order out of chaos in guiding technology. The scientific system of Mao Zedong Thought has again shown its brilliance. We are fully confident in foreseeing that in the march of the Chinese people toward rebuilding nature under the guidance of Marxism-Leninism and Mao Zedong Thought, our research in science of science will ride the waves and travel 10,000 li!

[Remarks] The several paragraphs on the trends in the development of recent and modern science and technology were added when rearranging the speech. The discussion of the second technological revolution was based on the paper "The Road of Technological Revolution and the Laws of Technological Economies" ("Science of Science," No 6, 1981) by Comrade Chen Ping [7115 1627] of the China Science and Technology University.

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SCIENCE PROGRAMS PREDICATED ON NEEDS OF ECONOMIC DEVELOPMENT

Beijing ZIRAN BIANZHENGFA TONGXUN [JOURNAL OF DIALECTICS OF NATURE] in Chinese Vol 3 No 2, 10 Apr 1981 pp 1-2

[Article by Guan Weiyan [4619 1919 3508] of the Physics Institute of the Chinese Academy of Sciences: "Scientific Programs Must Be Formulated Based on the Needs of National Economic Development"]

[Text] Recently, the Working Conference of the Central Committee decided on the major policy further to adjust the economy and to realize further political stability. In implementing this policy, science and technology should develop in coordination with the economy and society, and the promotion of economic development should be the foremost task.

When the State Planning Commission draws up long-range national economic development plans, it should include programs for the development of science and technology as part of the plans. It should also include scientific programs as programs for developing the national economy. This means scientific programs should be formulated according to the needs of national economic development so that the two can be organically and closely combined. In national economic development, a relatively fast rate of development can be realized only if we self-conscientiously utilize the newest scientific and technical achievements. Scientific endeavors can become prosperous and persist only when social needs serve as the driving force.

The key issue is that the state planning agencies should regard scientific and technical programs as their own affairs, place these programs under their control and exert efforts to use these programs to serve national economic development. If the planning departments merely provide a certain amount of funds for scientific research each year but do not assign tasks to the scientific research departments and do not inspect the results of such investment, then, scientific research and the needs of national economic development would be disconnected.

During the feudal era, natural science was not allowed to be widely and meaningfully applied in production because feudal production was based on manual labor of farmers and craftsmen. Farmers and craftsmen based their own labor on personal skills and skills acquired through experience and their knowledge of natural science unrelated to scientific theory.

When the feudal society changed into a capitalist society, the role of science changed. While pursuing profits, capitalists already learned to apply natural science in production. Capitalism made science serve it, and changed science from being the servant of theology into a slave of capitalism and a tool to enlarge surplus value and to pursue surplus profit. During the beginning period of the emergence of capitalism, the capitalist class decided to join the sciences in an uprising to oppose the church. Because of the influence of the capitalist class in creating profits in production, a new organ to study nature was born in Europe--the scientific academy. Rules of some scientific academies clearly stated that the most important task of a scientific academy was to promote the development of "mechanical skills" (i.e., technology). For example, the "minister of finance" of Louis XIV of France, Jean Baptiste Colbert, who became famous for his policies to protect capitalist industries and develop trade was at the same time a founder of the French Science Academy. This fact did not occur by chance. He specifically used to asked scientific workers to develop sciences that could promote the development of national industries.

As capitalist production developed, the capitalist class sought more and more help from natural sciences. When it was necessary, they were willing to spend huge amounts of funds to build laboratories and special academies for physics and technological sciences. Some large enterprises of capitalist nations have relatively large research and development departments. For example, IBM of the United States and the Bell Telephone Company all have large laboratories, and their research achievements are known worldwide. But more importantly, the research plans of these laboratories are formulated directly according to the needs of developing the companies' production and they directly serve to improve the companies' competitive capabilities. The results of a close combination of production needs and scientific and technical research are visible. The production of capitalist society is disorderly and chaotic, but the internal structure of every enterprise is highly organized and precisely planned.

Our socialist nation can apply those things that are effective in the internal structure of the individual enterprises of the capitalist world in the whole society so that scientific plans of the state can be self-conscientiously included in the needs of national economic development. In fact, only socialism can free science and technology from the yoke of capitalism so that they can be changed from a tool for profiteering to a means to increase the material welfare of the laboring people.

It is only possible to assure that scientific and technical plans are backed by the needs of national economic development when the state planning departments organize teams, draw up and monitor scientific and technical programs.

Scientific research can be divided into near term, medium term and long-range projects according to the period required for them to serve a function in production. In long-range plans, some medium term projects should be emphasized, i.e., those projects which could serve a function in production within 10 to 20 years.

Take energy as an example. Controlled thermonuclear fusion is a hopeful way for mankind to solve fundamentally the problem of the depletion of energy. But it is a long-range project and it will not produce any economic gain within about 50 years. Therefore, our national strength and the technological preparations of the past still cannot appropriately include this as an emphasis at present.

Nuclear fission power stations are medium term projects. They already generate over 10 percent of the total amount of electric power in industrially advanced nations. It is estimated that by the year 2000, the proportion of electricity generated by nuclear power throughout the world will surpass 30 percent. More than 20 nations in the world already have nuclear power stations while it is still a blank in our nation. Our nation already possesses a fair amount of technical reserve for such medium term projects. As long as we conscientiously plan the economic effects that may be possible during the next 5 to 10 years, we should include these projects as key projects.

Again, for example, the utilization of solar energy can also be feasibly realized in the near future. It is also a medium term project which does not require a large investment and which can produce quick results.

During the 1950's when the Soviet Union led in satellite technology, the United States reexamined itself and discovered that its weakness was in materials science. Therefore, it decided to establish over 10 materials research centers. As a result, it overcame its own weakness, and it enabled space technology to rapidly catch up and surpass the Soviet Union. Material science is related to all sectors of the national economy. And the continually emerging new materials in the international arena have become the most important material foundations of new technologies. We should select some projects that will produce medium term gains, organize forces and make breakthroughs in key areas.

Under the present situation created by the major decisions of the Central Committee, the scientific and technical battlefront should also implement the policy of further adjustment. It should review and examine current scientific research programs and plans. First, it should grasp those projects that require less investment, less time and that will produce quick results. Funds should be appropriated according to the tasks and the execution of the projects should be effectively monitored so that the investment can produce results. The effort should not be as it sometimes was: "Throwing money into the ocean, not even a sound could be heard." Secondly, in long-range plans, we should selectively grasp several medium term projects, organize forces, and make breakthroughs in key areas. I agree entirely with the policy of replacing efforts of enterprises to develop potential, renovation and improvement at an important position. But, to realize the miraculous "economic takeoff" experienced by some nations after the war, we should emphasize the use of the newest achievements in modern science and technology even more and to catch up with the others from a starting point at a higher level.

When Lenin analyzed the capitalist world during the era of imperialism, he pointed out the law of "latecomers surpassing the old timers." It was because

of this law that led to demands for redividing the colonies and war among imperialist nations. One of the reasons for "the latecomers surpassing the old timers" was that the latecomers did not carry the burden of outdated technology and they could freely use new technology. In industrial buildup, we should use the newest achievements in modern science and technology as much as possible while emphasizing technical improvement of existing enterprises. We should use new technical equipment and all methods to change fundamentally our nation's backwardness in industry and agriculture so that our nation's shortcoming of having a "weak foundation" can be changed to an advantage of "not being burdened."

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SCIENTIFIC RESEARCH READJUSTMENT NECESSARY TO NATIONAL ECONOMY

Beijing ZIRAN BIANZHENGFA TONGXUN [JOURNAL OF DIALECTICS OF NATURE] in Chinese Vol 3 No 2, 10 Apr 81 pp 3-6

[Article by Yang Jike [2799 4764 3784], professor at the Chinese Science and Technology University and deputy governor of the People's Government of Anhui Province: "Efficiency of Scientific Research Must Be Improved"]

[Text] During the period of readjusting the national economy, scientific research must also be readjusted correspondingly. Because national economic development often makes demands upon scientific research and because scientific research must first satisfy the needs of national economic development, therefore, readjustment of scientific research work in reality is an important link in the readjustment of the national economy. Without such readjustment, scientific research will not be able to combine with the national economy well, and it will go against our nation's situation and will hinder the realization of the four modernizations.

Readjustment of scientific research involves many subjects. Here, we will only talk about a few general views concerning one of the problems--improving work efficiency. A comparison of the funds our nation has spent over the years in scientific research and the achievements realized shows that the efficiency is not high. In some fields, it is even very low. If our scientific and technical circles can think of ways to improve efficiency with one heart and soul so that one man's achievement is worth two men's achievements, and the work that takes 2 hours to complete now can be completed in 1 hour, 1 square meter of space can be used as the 2 square meters of space required now, the utilization of one instrument can equal that of two instruments, then, scientific research will be able to improve at least fourfold instantaneously without increasing investment in capital construction, instruments and equipment. This is not empty talk. The key is conscientious and concrete work. The key to concrete work is to exert efforts to discover the potential of man, time, locality and materials so that they may be fully developed.

In developing human potential, we must first develop the potential of the group. In our nation at present, there is a serious imbalance in the distribution and assignment of manpower groups. One of the reasons that many talented people cannot develop their potential is that the groups to which

they belong are overly crowded. But, the fields in which they can develop their potential in a great way are barren and there is a lack of gardeners.

Such an imbalanced distribution and assignment of groups can be explained by two cases. One: We have recently learned from the founding meeting of the Second Light Industry Society in Anhui Province that the subordinate units of the Second Light Industry Department of Anhui Province has 160,000 people. Those possessing special knowledge constitute only 0.31 percent, a pitiful trifle. A reading of the topics of the academic reports showed that although many are beneficial to the economy, the number is also pitifully small. How can such a weak technical force enable light industry to realize lengthy and full development? How can we truly place light industry at an important position? But, the scientific research units in national defense have a gathering of talented people and university graduates are as numerous as the crucian carp swimming in the river. According to rumors, there was a couple who graduated from the department of electrical engineering at the 708 Institute. During the Cultural Revolution, they were persecuted and sent to the villages. They helped the production brigade of the commune in the farm village buy leftover bits and pieces of industrial material from the factories and taught several intellectual youths to make small electric motors which realized a profit of 200,000 yuan a year. The production brigade of the commune regarded them as indispensible and each month it gave them an additional 140 yuan in wages. After bringing order out of chaos, the 708 Institute invited them back to the institute and even allowed their promotion and raised their wages. Both of them wanted to remain in the farm village and were not willing to return to the institute. If they returned to the institute, they figured that they would be reserve personnel or redundant personnel, and like most other university graduates, they would not be able to develop their potential. Can we suggest that the scientific and technical personnel of the units subordinate to the National Defense Science Commission be readjusted so that a large number of them can be assigned to serve in the civilian light textile industry, electronics industry, electrical engineering industry, machinery industry, and chemical engineering industry which urgently need talent? The National Defense Science Commission places a lot of emphasis on systems sciences. If it can use the methods of systems science to study the problem of unified planning and utilization of the nation's scientific and technical talent, then it will surely not oppose this suggestion of mine.

Another thing: This year, Anhui Province invited experts of 15 disciplines to the northern and southern regions of the Huai River and western Anhui to inspect the comprehensive utilization of natural resources. This required the use of systems science to carry out comprehensive economic research. We invited a mathematical lecturer who knew the field to join the work. By chance we asked: How many teachers in your school's mathematics department are engaged in mathematical research that has practical uses in the national economy? This lecturer thought about it for a long time and said except for himself nobody else was interested and all were involved in abstract mathematics. At the same time, a comrade who had just returned from an inspection tour of the United States told me that the mathematics department of the state university he visited had 25 professors and 20 of them taught applied mathematics and concurrently engaged in scientific research, 5 professors taught

abstract mathematics, but they also were involved in applications research at the same time. This is because, only by engaging in applications research can they obtain extra compensation under contracts from enterprises. This is a comparison that is worth thinking about.

I believe, to readjust the imbalance of manpower between the "roads," the government should study and develop truly effective policies so that manpower can move toward a direction of joining with national economic needs under a controlled manner. To readjust the imbalance of manpower between abstract theoretical studies and practical applications, the government should study the policies of combining planned adjustment of manpower and market adjustment. Otherwise, the imbalance of manpower groups will continue to develop. This obviously is unfavorable to national economic development and the building of the four modernizations.

The second aspect in developing the potential of manpower is to develop the potential of the individual. For this, the urgent task at present is to implement and popularize the 16-character policy of "single project management, division of responsibility in levels, criticism and evaluation by peers, signing of contracts." According to reports by comrades who had recently worked at the Massachusetts Institute of Technology in the United States, the professors at that school are all concurrently involved in scientific research tasks commissioned by industries and mining enterprises, various social organizations and the government. Most use the contract responsibility system. The goals, funds and times are all fixed, but the professors signing the contract are responsible for how to utilize the funds and time including the hiring of workers and purchasing or processing instruments and equipment. In this way, funds are conserved, and only those instruments that are necessary and sufficient are purchased. Competition among experts is keen and they fear losing the next contract. Every worker works hard. This management method not only forces the direction of scientific research to be combined with the practical needs of industries, it is also a strong driving force behind every individual. It makes them have a strong sense of responsibility and they utilize every minute and second in their work and their efficiency is very high. In this way, the mobility and the potential of people are all fully developed, and their upward and downward mobility depends entirely on the level of their achievement. Seniority is not adhered to. To say that one of them equals two of us may be an understatement.

There is also a lot that can be done in the effective utilization of time. If the method of unified planning proposed and popularized by Prof Hua Luogeng [5478 5012 1649] is used in scientific research, a lot of time can be saved. I have seen laboratories for chemical analysis at several research institutes but frequently I do not see a large number of ordinary flasks that have been washed, such as test tubes, beakers, syphons, droppers, fractional distillers, etc. It can be imagined that such an analysis laboratory surely is not highly efficient in the utilization of time. Experiments must be like an operation performed by a surgeon on his patient. All tools, knives, scissors, tongs, needles, saws, etc., must be washed, wiped, sterilized and cleaned and placed orderly in the tray beside the operating table for one nurse to hand them over to the surgeon for use. The doctor should concentrate all attention on

the site of the operation and he does not even turn his head when asking for tools. Only in this way can the entire operation be performed within the shortest time. The efficiency is the highest, and the safety of the patient can be most completely guaranteed. The situation in chemical experiments is the same. If a tool has to be sought when it is needed, and then washed and cleansed in distilled water for use, won't precious time be wasted? This is really a pity. This seems to be a very insignificant thing, but it has a profound meaning. Because, if every procedure of every scientific and technical experiment takes into consideration how to conserve time, very quickly, a double amount of work can be done with half the effort. Therefore, I believe every scientific researcher, especially comrades leading the scientific research project groups, must learn the scientific methods of saving time and manpower, such as the method of unified planning. We must conscientiously study how to develop the potential of time.

In management, we must reward those who save time and punish those who waste time. In the past, the various unreasonable political labels such as "being a pure specialist" and the unshaken "permanent appointments" have created an actual result of punishing those who saved time and those who worked hard and correspondingly awarded those who wasted time, therefore, all of these were not scientific management methods. They are contrary to the goal of improving efficiency. To seek rapid progress in scientific research in such a way is trying to go south by driving the chariot north! If we can quantitatively survey and compile statistics on the distribution of the time required to accomplish various types of scientific and technical research tasks and predict the longest time required for similar types of scientific research tasks with a believability rate of 95 percent and fix the scheduled period by contract, then, we will be highly confident in completing the tasks on time or ahead of schedule, and we will surely improve the efficiency of time utilization greatly. If we use the method of rewarding and encouraging efforts to save time, then, the gain will not simply be doubling the accomplishment with half the effort.

There is also a lot of potential that can be developed in the use of space in our nation's scientific and technical research academies and institutes. The area effectively used for experiments at each research unit is generally smaller than that in foreign nations. Comrades who have visited foreign nations all know that laboratories in foreign nations are all very crowded, and scientific and technical personnel do not have office space. There are few managerial personnel. Therefore, the area occupied by offices is also very small. Frequently, to utilize space most effectively, it is common to carry out several research projects in the same laboratory. Cabinets line the walls everywhere in order fully to utilize space. In contrast, some of the research units in our nation have too much office space and some are even very spacious. Some laboratories have a very low rate of space utilization. Many lab tables are not used for a whole year but a lot of instruments and equipment that are never used are stored there like a museum of instruments. In our nation, it is rare to conduct several research projects simultaneously in one laboratory. And very few people have conscientiously studied how to utilize most effectively every square meter of space but many people ask for new buildings. If we conduct a study and a survey we will discover that the research laboratories

and groups often mark their boundaries clearly and they do not cross these boundaries. Because of the rampancy of the incorrect ideas of doing everything in a big way and "occupying" one branch of science, the laboratory group and the group circle at the research institutes believe the bigger the better, and the more space they occupy the better. As a result, the effective utilization of space in the buildings necessarily drops by a large amount. The faults created by this type of purely administrative method can be seen. A detrimental result thus created is that the efficacy produced by the investment in capital construction spent by the state is not high. Therefore, during this period of readjustment when hundreds of professions await development, readjusting the efficiency of space utilization at each scientific research unit and readjusting the management system are necessary. The method of readjustment is to use the method of combining economic management and administrative management on the basis of a general survey of the actual use of space at the localities. For example, fees can be levied on space which is not utilized. The criteria for such fees should increase in the degree of intensity of the space actually in use. In this way, each research laboratory group is forced to convert office space into laboratories or effectively utilize space that is not used, or let persons engaged in other important research projects use the space. If such economic management methods are used, it is entirely possible for the whole nation to develop potential space constituting 30 percent of the total without increasing the investment in capital construction of scientific research. Some localities can even develop potential space reaching 50 percent.

The potential of instruments and equipment is even greater. The survey of the nation's large computers this year fully explains this problem. Up to May of 1979, 332 large computers have been imported at a cost of $326 million, equivalent to nearly 500 million yuan renminbi. But, the rate of utilization is only a fraction of the effective operating time of 20 hours a day in foreign nations. Less than one-third of the computers operate up to 10 hours a day. Anhui Province has 234 large computers, only 3 operate over 8 hours a day. Even so, some units still insist on continued importation of large computers. If we investigate further to see what the projects are that run on the computers operating for more than 8 hours a day, we will often find that the proportion of important subjects related to national economic development is very small. This is so for computers, and it is also the same for other expensive imported instruments! Foreign scientists who have visited our nation have praised the sophisticated instruments displayed at some research institutes (please note, their rate of utilization is all very low) because they cannot afford to buy them! The director of the Laser Research Institute of the famous Max Planck Society in West Germany came to China to discuss cooperation in laser research. He said that the instruments seen in our institute were more sophisticated than the ones in his institute. Whether this is praise or a derogatory remark, it is difficult to tell!

The common phenomenon of a low efficiency of utilization and a low economic gain of such instruments and equipment is also contrary to the demands of our national economic development. I suggest that during the years of readjustment, we should conduct a general survey of all instruments and equipment valued at over 10,000 yuan throughout the nation. Necessary policy

readjustments should be made on the basis of this general survey, including policies governing the importation of instruments and equipment and management policies, and a whole set of economic measures should be taken to strengthen control and management so that each object can be fully utilized. For example, those instruments and equipment that are not being used can be taxed by levying an investment tax to force them to be used effectively and to be combined closely with the scientific research projects needed in industrial and agricultural development and national economic development. Those large instruments that can be shared or centrally utilized such as computers can be intensively utilized effectively, not letting them remain scattered, inefficiently utilized and idle. Such bad habits of blindly importing sophisticated instruments and equipment and going on a buying spree at year-end should be strictly prohibited. When necessary, laws must be established to seek legal responsibility for those who waste!

I do not know why, but everyone's eyes seem to be focused on export trade and foreign markets, while at the same time, the foreign exchange that does not come easily is wasted on some impractical sophisticated instruments. Several hundred thousand dollars are not even mentioned and even several hundred million dollars are spent without regret. I see that the time has come to turn the focus on the unpredictable foreign market in which we cannot yet compete to the vast domestic market and it is time to spend the precious foreign exchange on materials that have to be imported for national economic development instead of on expensive sophisticated instruments which are impractical in China.

Physiologists all know that the functional efficiency of the human organs is very high. The brain, the heart, the liver and the stomach all function with a high efficiency. The human body survives and progresses because of their highly efficient coordination. Scholars of bionics all know that the functional efficiency of any social mechanism will acquire vitality and will realize lengthy and sufficient progress if it imitates the efficiency of a biological entity. Of course, there are not exceptions in scientific research. The highly efficient union and utilization of manpower, time, locality and materials are like the highly efficient coordination of the organs of the human body, the brain, the heart, the liver and the stomach. The low efficiency in the utilization of human talent is like the retardation of the brain. The low efficiency in the utilization of time is like myocardial infarction. The low efficiency in the utilization of space is like hardening of the liver. The low efficiency in the utilization of instruments and objects is like the swelling of fat. If all four of these symptoms occur in the human body, life will end soon. In scientific research agencies, there will be intangible waste and no real results. For this, let us all call out: We must improve the efficiency of scientific research! We must include the readjustment of scientific research as an important content in improving the efficiency of scientific research. We must elevate the efficiency within 3 to 5 years to the level where it can be combined closely with national economic development, and we must elevate it to the level where it can correspond with the steps of progress of the four modernizations. We must seize every minute and second by being thrifty and by calculating carefully. We must develop the potential of manpower, materials, time and space and utilize them, and quickly shorten the distance between the level of China's science and technology and the world's advanced level.

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STRESSING SCIENCE, TECHNOLOGY IN ECONOMIC DEVELOPMENT

Beijing RENMIN RIBAO in Chinese 5 Apr 82 p 5

[Article by Li Jianbai [2621 0494 4101]]

[Text] The new policy on scientific and technological development formulated by the Party Central Committee is a momentous decision based on historical experiences as well as the only correct policy for China's science and technology.

That we have come to this conclusion is primarily because it is completely compatible with our national conditions and with the demands of our economic construction and social development. As shown by our experiences since the founding of the nation, especially in the past 3 years, we must, in China's socialist construction, change the old practices under the "left wing" ideological guidance, start truly from our practical conditions, and follow a new path which is more realistic in speed and better in economic benefit and which gives the people a greater material benefit. With the basic change in the economic construction policy, one should say that science and technology, as productive forces, have made great contributions in promoting the development of the national economy. However, we must also realize that, for a time in the past, many urgent problems were found in the focal points of scientific and technological development and in the management system, e.g., the lack of close integration between scientific and technological and economic developments; the stress on level in certain studies while overlooking the results, and inadequate attention on the production of consumer goods; the lack of smooth channels among research, trial manufacturing, production and application; the lack of necessary coordination in scientific research between the military and the civilian and among the various civilian systems, the dispersion of strengths and the duplication of tasks; the inadequate digestion of imported technology and the lack of innovation, etc. If these problems are not basically solved, science and technology will not fully develop their promotive effect on economic construction. Conversely, the lack of improvement in the economy and of funds and conditions will also impede the development of science and technology. Therefore, while the new policy answers the need of the basic change in the economic construction policy, it will also promote the coordination of science and technology with the economic and social developments.

Next, the new policy is also compatible with the laws of economic and scientific and technological developments. Whether industry or agriculture, or any other field, modern production is all a product of science and technology, or, one might say, the materialization process of science and technology. Science and technology, as an active element of the productive forces, are playing an ever greater role in the economic growth. The conditions of the major economically developed nations in the world indicate that, at the beginning of this century, their economic growth was achieved mainly by means of enlargement and extention. In other words, the growth was achieved by increasing the equipment, enlarging the investment and enhancing the labor force. After the thirties, especially after World War II, it has been mainly by means of science and technology. We were not very conversant of these facts. The moment developing production was mentioned, it meant setting up a big display, launching capital construction and reproducing the obsolete technology, and we paid for the mistakes. This lesson must be well assimilated. In terms of the development of science and technology, there is also the issue of the goal which calls for solution. In scientific research, naturally we want to explore the unknown, catch up with and surpass the advanced, create more results and train more talents, but the most basic thing is to raise the productive forces and promote the economic and social developments. Apart from this basic goal and from the needs of economic and social developments, scientific research will turn into a sourceless water and rootless tree.

Today, there are many reasons for the failure of China's science and technology to develop their role fully. The development and application of science and technology are determined by the demand of society. However, this demand is usually only a latent necessity. To turn it into reality depends, to a large extent, on correct policies and on the understanding of the role and position of science and technology on the part of our leading comrades of the various levels. Summarizing the past and examining the thinking of our leading comrades, we find that our understanding of science and technology is indeed inadequate. There are also many incorrect things in practice, which are concentratively manifested in two aspects: lack of harmony between scientific and technological development and the development of the national economy; neglect of the role of the scientific and technical personnel, making it difficult for them to give full play to their expertise. After the downfall of the "gang of four," especially since the 3d Plenary Session of the 11th Party Central Committee, the understanding of the importance of science and technology has gradually improved. But, to give them their proper position in the modernization construction requires that our leading comrades of the various levels further raise their consciousness and perform much concrete work. We must realize that today, if we still fail to understand the importance of science and technology and to coordinate them with the economic and social developments, it will no longer be a simple problem of the leadership and work methods, but a momentous issue of whether we can accelerate the building of a modern socialist power. Hereafter, if we give no serious attention to science and technology, but remain shortsighted and stick to the old ways, we will pay even more dearly and commit historical errors.

To fully develop the role of science and technology in Heilongjiang Province during the 6th 5-Year Plan is to give full play to the superiority of our

province, tackle properly the key problems in science and technology, spread the scientific and technological achievements which are large in volume and wide in area and which produce marked economic benefits, and seek to make the factor of scientific and technological progress play one-fourth to one-third of the role in the economic growth.

1. Actively develop research work by centering on achieving the strategy of agricultural development. To build our province into a modern agricultural base with commodity grain as the key and overall development of economic crops and diversification, and gradually realize the "three-three system," we must organize a comprehensive survey of our natural resources and an agricultural, industrial and commercial economic survey, and formulate a scientific overall plan on agricultural divisions and land utilization, in order to rationally develop and utilize our natural resources and provide the basis for agricultural modernization. Currently, we particularly need to achieve noticeable results in cultivating and spreading superior varieties, remolding the farming system, improving the low-yield soil, properly handling the crop layout, changing the structure of chemical fertilizers, introducing rational fertilizing, producing insecticides of high efficiency and low residual poison, and selecting complete sets of farm machinery.

2. By actively developing studies of technology on consumer goods production. We must promptly readjust the service direction and the composition of products of the machine industry, and study and manufacture suitable advanced technical equipment for light and textile industries, food processing and the building industry. We must fully utilize the superiority of our natural resources and concretely promote the comprehensive utilization of lumber, beet, flax, soybean and corn. We must study and develop new textile products using flax, wool, silk and chemical fiber as raw material, master promptly the techniques of handling subsequent to dyeing and arranging, improve the quality of chemical fiber products and increase the designs and varieties. We must study and produce concentrated, convenience and children's foods of high nutrition, superior quality and low cost, develop the microbial fermenting technique, and carry out the study of nutritive composition. We must study and manufacture new type building materials and components and provide advanced technology to increase the output of cement, glass and ceramics.

3. Actively develop studies on the techniques to develop and conserve energy by centering on solving the energy shortage. To solve the energy problem, we must, in the long-range view, stress development and conservation equally; in the short-range view, we must give priority to conservation. Heilongjiang is one of the coal and petroleum bases in the country. We must stress the study of the new oil mining technology, assuring the sustained high and steady yield of the oil fields, and improve the comprehensive mechanization level of coal mining, greatly enhancing the coal output. In energy conservation, we must vigorously study and provide new technology, material and equipment for conservation and develop the techniques of coal gasification and comprehensive utilization of inferior coal. Solving the rural energy problem, an urgent task today, must be given preferential consideration. First, we must organize forces to work out rural energy divisions in areas with firewood shortage and, in accordance with the principle of consideration of local conditions,

supplement each other in many areas, comprehensive utilization and practical benefit, plant fuel forests, promote methane production and small hydroelectric stations, while actively utilizing solar and wind energies, and form a rational energy composition.

4. Studying and solving the crucial technical problems by centering on developing the potentials of existing industries. To develop the potentials of existing industries by means of technological remolding is a strategic measure to achieve the beneficial circle of production. In technological remolding, we must start from reality and gradually form a rational technological composition. It will be impossible, within a fairly long period of time, for all the industries to adopt the newest technology and one-sidedly seek automation. We must integrate the overall technological remolding with the minor remolding of a part of the equipment, technology and products. We must focus on improving the economic benefits, conserving energy and raw and processed materials, reforming the products structure, and rationally utilizing resources, and consider quality improvement, cost reduction and higher production of marketable products the main targets. We must fully develop the superiority of the machine industry of our province and serve the technological remolding of the national economy.

5. Introducing scientific and technological achievements in large areas over a wide range by centering on improving the economic benefits. According to incomplete statistics, Heilongjiang, since the founding of the nation, has made a total of more than 6,000 achievements and imported a number of new techniques from abroad and within the country. Military production also contains many advanced techniques and technology suitable for civilian use. All these are ready-made productive forces and valuable assets already in hand. So long as they are conscientiously introduced and applied, they will produce a great economic benefit.

6. Properly handling the technological reserves by centering on further developing the national economy. While developing and studying production technology, we must appropriately plan the study of applied theories. In agriculture, industry, medicine and public health, we must actively study such new technologies as electronics, computer science, atomic energy, laser and remote sensing and suitably launch research in genetics, growth and development theories, and control techniques. We must strive to make greater progress in the study of special semiconductor elements and semiconductor sensor parts, and in human reproduction and physiology.

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'RENMIN RIBAO' DISCUSSES PROMOTING SCIENCE, TECHNOLOGY

Beijing RENMIN RIBAO in Chinese 22 Mar 82 p 5

[Article by Hu Ping [5170 1627] and Deng Nan [6772 2809]: "In the Face of the New Situation--Looking Back on the Implementation in the Past Year of the New Policy for Scientific and Technological Development and Looking Forward to its Prospects"]

[Text] At present, an upsurge of relying on science and technology to promote economic and social development is in the making throughout the country. The strategic thinking of "economic and social development must rely on science and technology, and science and technology must serve economic and social development" is beginning to take root in the hearts of the people. Science and technology as an effective means of policymaking and as a powerful function of productive forces have become increasingly apparent in both the macro and micro aspects.

Since the founding of the People's Republic, several upsurges have appeared in the development of our scientific and technological undertakings. In 1956, following the development of large-scale economic construction, the first upsurge of the "march toward science" appeared in our country, and important results were achieved. Unfortunately, it was very quickly interrupted by the political movement which followed. The National Scientific and Technological Work Conference convened in Guangzhou in 1962 cleared up the "leftist" mistakes of the latter part of the 1950's and adopted a series of measures to consolidate and strengthen scientific and technological work. There was a new development in scientific and technological undertakings. However, the "Great Cultural Revolution" which began in 1966 again caused a new and greater setback to scientific and technological undertakings. The National Science Congress held in 1978 was a great turning point in the development of scientific and technological undertakings in China. This congress thoroughly criticized politically the long-standing "leftist" abuses which seriously fettered the development of scientific and technological undertakings for many years, implemented the party's policy for intellectuals as well as other policies and expounded the idea that science and technology is the Marxist principle of productive forces. This had a far-reaching impact on the development of scientific and technological undertakings in China. However, the inadequacy was that this congress did not directly link up the development of science and technology with economic and social development and did not put forward the effective

method and measure of relying on science and technology to promote economic and social development.

new policy for scientific and technological development put forward by the CCP Central Committee in 1981 hallmarked a new stage in the development of scientific and technological undertakings in China. The central idea of this new policy is to strengthen close integration and coordinated development between science and technology and the economy and society. Under the impetus given by this new policy for scientific and technological development, new changes have appeared on the scientific and technological front in the past year.

1. Many party and government leaders from the Central Committee to the localities have paid attention to further strengthening scientific and technological work. This kind of attention is no longer just verbal. They are beginning to regard the development of scientific and technological work as an important component in the development of strategy. Many districts and departments throughout the country have already integrated science and technology with the economy, and proceeding from the economic characteristics and industrial superiority of their own district and department, formulated an overall plan for the coordinated development of science and technology and economy. They have determined the orientation and problem of scientific research according to the needs of economic development, and at the same time, also relied on science and technology to tap latent productive capacity and to carry out a technical restructuring of the national economy. They have obtained definite results in getting resources, energy, quality, output and economic returns from science and technology. Facts have shown that the development of science and technology is no longer a less essential "soft" task, but it is a "tough" task capable of affecting the overall situation.

2. The broad masses of scientific research units as well as scientists and technicians have heightened their consciousness of serving economic and social development and have further defined the basic goal and orientation of developing science and technology. While steadily strengthening basic research, China at present has concentrated its main force on applied research and developmental research. Many units have readjusted the problems and items of scientific research, strengthened direct ties with production departments, accepted research tasks and assignments from production departments, supplied technical advice and service to the whole society and gradually developed the orientation of scientific research to meet the needs of society. This has not only effectively promoted the development of production, but has also stimulated the work of the units themselves.

3. The role of scientists and technicians in modernization is being further respected. They are not only bringing their specialities into play in such concrete work as scientific research, planning and production, but they are also playing an important role in the strategic policymaking of the whole district, the whole department and even the whole country. Some policymaking organs are beginning to pay attention to the views of scientists and specialists and carrying out a feasibility study before they adopt an important

measure. Some scientists and specialists with organizational and administrative ability have joined leading bodies at various levels.

4. There has been new progress in the popularization and application of scientific and technological achievements. As a result of implementing the principle of "four shiftings" (shifting scientific and technological achievements from the laboratory to production, shifting from advanced areas in the country to backward areas, shifting from military use to civilian use and shifting from outside the country to inside the country). The scientific and technological achievements of many places no longer remain at the "sample, souvenier and exhibit" stage but can now be more quickly applied in production. Many new forms of technical transformations, such as various forms of contract systems, compensative technological transfers, scientific research and production joint ventures, technical advice and services, and technical achievements fairs have been created in practice.

5. Great developments have taken place in the work of enterprise-run scientific research. After expanding the decisionmaking power of enterprises and setting up the economic responsibility system, many enterprises changed their longstanding tendency of neglecting the technical structure of the past and showed a greater interest in product and technical quality. According to the investigation of some provinces and municipalities, among the important technological achievements scored in 1981, about one-third to one-half were supplied by enterprise-run scientific research projects. State-run scientific research has distinctive characteristics and superiority and can quickly provide economic returns. Some of the enterprises, which were always operating at a loss, have quickly turned losses into profits and changed their features because of a breakthrough in technology.

6. A new upsurge in studying and applying science has appeared in the vast countryside. The agricultural production responsibility system has greatly aroused the demand of the broad masses of peasants for "scientific farming." Apart from the existing agricultural techniques stations in the countryside, there are now such new things as "agricultural science households," and they are playing a hardcore as well as exemplary role in scientific farming. In the past years, various measures have been adopted in many districts throughout the country extensively to popularize the achievements of scientific research in agriculture and notable economic results have been achieved. There is a marked improvement in the position of agricultural scientific and technical cadres and they are generally welcomed by the peasants.

7. The channels of scientific research funds are beginning to develop toward diversification. In the past, scientific research funds came under the unified allocation of state financial departments and the amount of funds had no direct connection with the economic returns of scientific research achievements. At present, the economic returns of scientific research achievements receive widespread attention from society. Scientific and technological investment has now become a "ten thousandfold profit" matter. The channels of investment have been increasingly diversified. Apart from unified state financial allocations, many localities, departments and enterprises have in varying degrees all squeezed out funds for scientific and technological investment. Moreover,

the additional income obtained by the scientific research units from the transfer of technology, supply of technical services and sales of scientific research achievements and trial-manufacture products has also become an important source of funds for the scientific research units.

8. There is a new way for the rational circulation of qualified scientific and technical personnel. Regarding the employment of scientific and technical personnel, apart from unified assignment by personnel departments, some localities have been experimenting with "rational circulation" within a given framework. Some have "invited applications" for technical guidance from scientific research units and institutions of higher learning. Some have formed "joint ventures" with provincial, municipal and enterprise research units and used outside scientific and technical forces to serve the production of their own province and municipality.

9. Large numbers of newly emerging medium-size and small towns, which relied on science and technology to quickly change their features, have appeared throughout the country. The 60 percent increase in profits and the 40 percent increase in output of some urban industries have been obtained from technical progress. These towns have one distinguishing feature in common, and that is they have really given prominence to scientific and technological work in modernization and have given an impetus to the whole economy and to the rapid development of industrial production in particular.

10. There have been great developments in the study of scientific and technical policies. Last year, China held two national conferences for the study of scientific and technical policies. At present, almost all provinces and municipalities throughout the country have set up organs for the study of scientific and technical policies. Quite a few districts and departments have set up research organs for the study of science. These organs and organizations have, on the basis of conducting a vast amount of investigation and study, put forward many important views and suggestions on implementing the new scientific and technical policies, restructuring our scientific and technical management system, studying our strategy for social and economic development and forecasting the trends of scientific and technical as well as economic development both at home and abroad.

Naturally, we should see that the implementation of the new policy for our scientific and technological development is only just beginning. There are still many problems and difficulties. After the implementation of the new scientific and technical policies, there will be corresponding changes in our scientific and technical management system, scientific research and planning system, scientific research funds management method and scientific and technical personnel management method.

In the face of this new situation, our comrades on the scientific and technical front hold that we must first grasp the following links:

Change the Outmoded Work Method of Responsible Scientific and Technical Departments

In implementing the new policy for scientific and technological development, there should be a big change in the leadership style and work method of the scientific and technical departments at various levels. They must break away from the former habit of limiting themselves to a narrow circle of departments and from the same old ways of administrative management and document reports. They must closely cooperate with other departments and grasp important problems relating to economic and social development together. Everything from determining economic targets, reforming the economic structure and deploying productive forces in a rational manner to surveying and utilizing resources in a rational manner, restructuring the technology of enterprises and drawing up technical and economic policies should be grasped. They must enliven their thinking, enliven scientific research organs and enliven activities for finding ways of making money for scientific research. They must grasp policies, coordination, industrial superiority, uniting scientific research and production and popularizing scientific research achievements. By means of investigation and study and the carrying out of guidance according to category, they must unify various tasks on the path of closely integrating science and technology with coordinated economic and social development.

Continue To Grasp Properly the Work of "Four Shiftings"

The carrying out of the "four shiftings" is the scientific summing up of both the positive as well as negative aspects of the experiences of our scientific and technological work in the last 30 or more years. The present question is how to quickly, effectively and persistently carry out these kinds of changes. This involves restructuring the economic system of the state and also involves the economic policy, tax policy, price policy, credit policy, technological secrets policy and patent right system of the state. At present, many forms of shifting have been created in various parts of the country. However, most of them are still at the primary stage. We must continue to improve them, theoretically explain them, systematically perfect them and set up laws to protect them.

Organize Forces To Make a Concentrated Attack on Science and Technology

At present, in the solving of some important scientific research problems, there are still such defects as duplication, dispersed manpower and lack of unified planning and coordination in many departments and districts. Experiences from both at home and abroad have indicated that in order to solve important scientific and technical problems, we must organize the forces of various sectors, rationally carry out distribution of labor and cooperate in making a concentrated attack before we can get double the result with half the effort. For the sake of organizing properly a concentrated attack, we must first select a number of projects; make proper arrangements for funds, materials and manpower; define responsibilities and strictly carry out periodic inspections. Not only key projects of a national nature must carry out work in this way, but some of the projects of a departmental or regional nature must also carry out work in this way. In the concentrated attack,

responsible scientific and technical departments must closely cooperate with the departments and units concerned and actively bring their organizing and coordinating role into play.

Actively and Reliably Carry Out the Restructuring of the Scientific and Technical Management System

Following the implementation of the new policy for scientific and technological development, certain contradictions in the scientific and technical management system have become more clearly exposed. The restructuring of the scientific and technical management system has become imperative. This kind of restructuring deals with a wide range of sectors including perfecting scientific research planning, expanding the decision-making power of scientific research units, implementing compensative technological transfer, perfecting the scientific research contract system, diversifying the channels of scientific research funds and using qualified scientific and technical personnel in a rational manner. Even though at present our country is still in the period of readjustment and all-round restructuring cannot be carried out, we should actively create conditions by beginning to restructure parts which are already matured, accumulate experiences and gradually popularize them. We cannot passively wait. If a unified method for the whole country cannot be formulated to solve some of the problems for the time being, we could formulate some provisional rules and regulation based on the actual situation of our own district or department to expedite the development of work.

Strengthen the Study of Scientific and Technical Policies

The study of scientific and technical policies is a kind of comprehensive research spanning departments and disciplines and involving the fields of politics, economics, society, science and technology, and education. Experiences in many countries have indicated that the study of scientific and technical policies has a very important bearing on the development of scientific and technological undertaking and on the coordinated development of science and technology, society and economy. Apart from the several problems mentioned beforehand, there are many problems we must study at present. A district or a department in particular must firmly grasp industrial superiority, key projects and their economic returns, explore correct ways of applying science and technology to promote development, really act as "brain trust" and "staff officer" to leading members at various levels and make contributions to scientific policy making.

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'RENMIN RIBAO' REVIEWS SCIENCE, TECHNOLOGY DEVELOPMENT

Beijing RENMIN RIBAO in Chinese 6 Jun 82 p 3

[Article by Liu Ying [0491 7336], vice president of the Central China Engineering College: "Several Questions on Developing Our Country's Scientific and Technological Work"]

[Text] In order to speed up our scientific and technological development, several questions on policy have to be studied and resolved.

1. Emphasis should be placed not only on the research work of the science academies and research institutes, but also on the significance of the institutions of higher learning as a front army of scientific research.

The First 5-Year Plan saw great development in higher education as faculties and departments were readjusted and new colleges completed. Some government departments, however, held a misconception that scientific research should be distinguished from the training of qualified personnel since science academies and scientific research institutes were responsible for scientific research, whereas institutions of higher learning were responsible for the training of personnel. Modeled on the Soviet Union's system, institutions of higher learning were distinguished from scientific research institutes upon the completion of science academies and other scientific research institutes. Consequently, the material conditions and funds of the institutions of higher learning for scientific research have been ignored for a long time.

Scientific research is mainly done at institutions of higher learning in some industrialized countries such as Britain, the United States, West Germany, Japan, France and Switzerland. Such institutions do not have large and independent science academies. Although Russia's science academies are distinguished from its institutions of higher learning, much importance is attached to cooperation. Many academicians are professors at institutions of higher learning. Other national scientific research units are closely related to institutions of higher learning. I paid a visit to the famous Max Planck Research Institute in West Germany and the West Germany material inspection headquarters in West Berlin in 1981. They have both established close ties with Stuttgart University.

Leaders of various departments in the research units are university professors. The laboratory facilities of the research units are open to university graduate students to write their research papers and to perform their experiments. The Government of West Germany pays much attention to the scientific research done at universities. I was much impressed by their concern in training young and talented personnel, the sophistication of laboratory facilities in their universities and the intensity of research work.

Our poor management in the division of science academies and institutions of higher learning has given rise to several problems. Older and senior technologists of science academies were mainly transferred from institutions of higher learning. They seldom taught at these institutions after their transfer, thus weakening the training of qualified personnel at institutions of higher learning. All or most of the advanced laboratory facilities are imported for research units and factories, because of an acute shortage of funds, the laboratory facilities of such institutions are obsolete and backward. Most of the facilities date to the early fifties. The backwardness of facilities not only hampers the development of scientific research, but also impedes the training of qualified personnel. Last year I paid a visit to universities in Britain, the United States, West Germany, and Japan. Most of the universities in these countries provide their students with electronic computers. The universities in Japan, West Germany and the United States have their largest and most recently developed electronic computers installed on the campuses. Until the end of 1979, our state had installed 300-odd large, medium and small electronic computers in scientific research units and enterprise units. Institutions of higher learning are seldom equipped with such computers. As a result, the students have great difficulty in learning to operate them. In fact, such computers are completely new to many university lecturers, and owing to a shortage of operating personnel, the rate of utilization of computers in research and enterprising units is very low. Other equipment and facilities also have a similar situation. Last year when I paid a visit to the Zeiss Company in West Germany, officials there told me that each of the most sophisticated, three-dimensional multipurpose optical testing instruments cost several hundred thousand German marks. China has ordered eight, but none are installed in the institutions of higher learning.

The institutions of higher learning do not have or have only very little funds for scientific research. The funds for scientific research within the 1981 operating budget of the Ministry of Education has only 1/20 of that of the science academies. The training test scores of doctors and teachers in institutions of higher learning examined and approved by the degree committee of the State Council were three times and five times better, respectively, than those doctors and teachers of the nationwide scientific research institutes. The shortages of material conditions for doing scientific research in institutions of higher learning has become more acute.

Faced with such difficulties, the teachers in the institutions of higher learning have worked energetically and scored remarkable results in scientific research under the guidance of the party. Quite a few items won the national invention award. In the past 2 years, some teachers from institutions of higher learning went abroad as visiting scholars. With the help of superior laboratory

facilities and computers, quite a few scholars scored remarkable results in scientific research within a very short time. The five inventions concerning hydraulic pressure by Comrade Lu Yongxiang of Zhejiang University at Essen University, West Germany, was only one of the examples of success which clearly shows that the institutions of higher learning have great potential in developing our science and technology.

Our science academies and other scientific research units have, of course, made great contributions to the development of our scientific undertakings. However, more scientific results would have been scored if our institutions of higher learning had been provided with better material conditions, since the manpower at our institutions of higher learning is 10 times that of the science academies. Furthermore, we have more than a million outstanding students studying at such institutions. The young people are quick-witted and innovative; these are the indispensable qualities for scientific research.

Through the scientific research done at the institutions of higher learning, the teachers come into constant contact with various scientific fields. They can improve their academic standards and enrich course contents with the latest scientific development. They can also help their students study in a scientific atmosphere, develop their innovative power and research potential and foster a big army of innovative scientists and technologists for our state.

It is evident that we have suffered a great loss since we ignored the significance of the institutions of higher learning as a front army of scientific research. It is time for us to resolve the existing question on policy and cognition.

2. Emphasis should be placed not only on the study of natural science, but also on technological research which plays a decisive role in strengthening our state.

Natural science includes mathematics, physics, chemistry, astronomy, geography, and biology. I describe technological science as including the fields of agronomy, medicine and various fields of engineering such as hydraulic engineering, civil engineering, mining, metallurgy, mechanical engineering, electrical engineering, chemical engineering, and the new and still developing fields of automatic control engineering, biological engineering, management and systems engineering. Natural science is the theoretical basis for technological science. Developments in technological science give rise to further developments in natural science. Although they are closely related, one cannot be replaced by the other.

The study of natural science is vital to a country. First, it can add much to the treasure house of human knowledge. Remarkable results in the study of natural science always contributes a great deal to the scientific development of mankind. Second, it can promote the development of our technological science. The study of technological science has a direct bearing on the agricultural prosperity and public health of a state. The study of technological engineering even has a direct bearing on the national economy and defense. It

can be said that the study of natural science is aimed at serving mankind as a whole, whereas the study of technological science is aimed directly at helping and developing our agriculture, public health, economic construction and national defense. In general our state is poor and backward, with very limited resources and manpower for scientific research. The great policy problem is to decide whether we should spend most of our resources and manpower studying natural science or place our emphasis on the study of technological science so as to strengthen our country and to raise the standard of living of our people.

The study of technological science has long been neglected and it only plays a subsidiary role. The Chinese Academy of Sciences, with its focus on the study of natural science, was established in the fifties. The Chinese Academy of Social Sciences, with its focus on the study of humanities, was established in the late seventies. However, the establishment of an academy of technological sciences has never been considered.

Eighty percent of the members of the Academic Affairs Committee of the Chinese Academy of Sciences, which is the policymaking body for our science and technology, are natural scientists. Only a few engineers and technologists, who are many times greater in number than the natural scientists, have been nominated as members of the technological engineering panel.

The scientists seen in the press during recent years are mainly natural scientists such as mathematicians, biologists, etc. Therefore, those academically outstanding youngsters take natural science, particularly mathematics and theoretical physics, as their objective. It is very difficult for departments such as agriculture, medicine and engineering to enroll outstanding youngsters.

During his visit to China 2 years ago, Professor Chen Xingshen, a world famous American-born Chinese mathematician, was deeply concerned over the situation. He maintained that a country would be in danger if all of its outstanding youngsters apply to enroll in mathematics and physics departments. Professor Xie Xide, vice president of Fudan University and a famous physicist, also encouraged our most outstanding youngsters to study agriculture, medicine and engineering to fulfill our four modernizations. Professor Chen and Comrade Xie clearly knew the significance of natural science and its limitations in developing national economy and defense. Hoping to speed up our four modernizations, they gave us their sincere advice.

We should, of course, continue research in the natural sciences. However, as we are deficient in manpower and material resources, emphasis should be placed on various technological studies which are closely related to the development of our national economy and defense.

I suggest the establishment of an academy of science and engineering as a leading body to lay down plans for the study of technological science, and to give and examine assignments. Only a streamlined steering team and an administrative department are to be established. The setting up of too many research units is unnecessary. Under the direction of the academy of science and

engineering, experts and leading cadres will be called together to work out a priority list for the studies of technological science which meet the needs of our economic development and the construction of our national defense. The academy will sign contracts with the existing institutions of higher learning, research institutes and enterprise units which will be provided with funds and are required to complete their research as scheduled. Bringing the wisdom and enthusiasm of our scientists and technologists into full play by means of appropriated task funds is an effective way to speed up our economic development within a shorter period of time.

3. Emphasis should not only be placed on producing sophisticated goods, new goods and the research on technological innovation, but also on the research work of improving the sophistication and reliability of various goods.

Directed by the principle of self-reliance, our scientists and technologists have done a lot and contributed much to the setting up of our industrial system and to the improvement of our highly sophisticated technology.

However, our technological work is confronted with the problem that both the quality and quantity of many of our products are, to various extents, poor and substandard. They are unreliable, nondurable, energy-consuming and ineffective. The cost of production is high and the supply of components inadequate. The failure of our products other than our light industry, handicraft and textile industry, to meet our own competitors' standards hampers the development of our economy.

For instance, our iron and steel industry, having an annual output of more than 30 million tons, has a large stock of goods, but because of their poor variety and quality, we have to import several million tons of steel materials annually. Our mechanical industry is large, foreign capitalists marvel at the size of many of our mechanical plants. However, many of our products are backward. We have a large lathe industry which started studying computerized mechanical tools in the late fifties, nearly the same time as Japan. Today most of the foreign mechanical tools are computerized and automatic, whereas ours are mainly manual. Our internal combustion engine industry has an annual output of 60 million horsepower. Our auto and tractor industries are quite large. But our internal combustion engines, automobiles, and tractors have failed to solve the longstanding problems of oil, water, and gas leaks, high oil consumption, air pollution, and short service life. M290 20-hp diesel engines, manufactured by the Hubei Diesel Engine Factory, were sold to Hong Kong merchants at $1,200 each. The engines were dissembled and reassembled; oil pumps and oil tubes were replaced by those of a famous brand. The service life of the engines was largely extended and they were sold at a high price. This clearly shows that though some of our goods have been mass-produced for many years, the key technology of improving the quality and quantity and of extending the service life has not yet been acquired.

The reason why the quality and quantity of many of our goods are poor is that our scientific research work has been focused on the study of the creation of new products, new technology and new materials. The study will come to an end once the products, technology and materials are appraised. The study of new

products is often focused on the study of the products as a whole, without any indepth study on the system, the components or the combination of components which make up the products. As a result, the study on the products as a whole is established on the basis of unknown elements. The products will go into operation once they are appraised. There is insufficient systematic observation, study and resolution on the problems arising from the utilization of such products.

Another reason why we cannot improve the quality and quantity of our products is that we seldom carry out research work on the related materials, technology, and the standard pieces such as the solid pieces and the sealed pieces. Last year when I visited West Germany, I was much impressed that even a highly industrialized country like West Germany still carries out many indepth studies on metal materials, nonmetal materials, high temperature ceramic materials, machine components, screws and welding seams. I think that the West Germans have created the conditions for improving the quality and quantity of their products. We should follow their example.

4. During the course of scientific research, we should pay much attention to theoretical writing. However, we should attach more importance to arduous experimental work.

All along our intellectuals have paid close attention to theoretical knowledge while ignoring the practice of production. In the past few years, they have tended to be in favor of writing theoretical papers instead of doing arduous experimental work. Moreover, our present experiment facilities are relatively obsolete. The means for collecting figures and analyzing them are very backward. Experimental work requires the gathering of materials, facilities and equipment. It also requires technologists to take up difficult general work. Consequently, many technologists are inclined to make theoretical analyses while ignoring or trying to evade practical tests. Theory and practice should supplement each other. Only through practical tests can theories give full play to the development of science and technology. Without practical tests, theories often bring forth incorrect results and hamper the development of science and technology even though they sound reasonable.

Computers have developed greatly in recent years. Problems that were very difficult to work out in the past can now be easily resolved. Theoretical calculation is included in many new scientific subjects. If properly handled, the technology of calculation can provide a guideline for practice and shorten the cause of trial-and-error practices. Owing to the complication of the practical situation, the plurality of factors which affect the situation, and the fact that the drafted mathematical and physical models have failed to reflect fully the situation, the results of calculation do not often conform to actual conditions. Foreign countries often work out their design of high-performance diesels such as cylinder heads and cylinder blocks through computerization. However, serious thermal cracking still occurs during actual revolution tests. The solution to this problem often goes beyond the realm of calculation. It can only be resolved through arduous tests. Owing to our blind faith in theoretical calculation and to our ignorance of arduous

experimental work in components, systems and engines, our self-manufactured high-powered internal combustion engines easily break down after a short period of use.

Therefore, in order to contribute to our national economy and to the construction of our national defense, we should pay more attention to the implementation of arduous experimental work, and should not be inclined to study theories and to write flashy papers.

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NEED FOR OVERALL SCIENCE POLICY STRESSED

Shanghai WEN HUI BAO in Chinese 16 Apr 82 p 3

[Article by Huan Xiang [1360 6763], vice-president of the Academy of Social Sciences: "An Overall Sciences Policy Is Needed"]

[Text] During the current period when our country is carrying out its grand plan of the four modernizations, an overall science policy of planning and development is urgently needed, one that will organically integrate natural sciences, technical sciences, and social sciences. In the past, these three science fields have each isolated themselves and showed no relationship to each other. There has been a tendency to overemphasize the basic theories of natural sciences and neglecting or even downgrading social sciences and technical sciences. It is hoped that this tendency will be avoided in the future.

First, from the point of view of our national construction, our economic structure is now undergoing a change. To speed up this changing process, it is necessary to actively develop science and technology. However, the development of natural sciences and technical sciences cannot be separated from the social conditions. The development of natural sciences and technical sciences will inevitably bring with it new social issues, such as employment, education, investment direction, and foreign economic cooperation. These issues will require joint study and solution by the social scientists and the science and technical workers. Also, the major overall construction projects which affect funding resources, energy resources, ecological conditions, industrial and agricultural relationships, population distribution, transportation and communications, and military considerations must be studied on a unified and total scientific, technical, economic, and social basis to avoid long-term disasters caused by neglect in considering certain areas. These will require close cooperation between natural science, engineering and technical, and social scientists.

Second, from the point of view of the direction in the development of modern sciences, the division within the natural sciences, social sciences, and technical sciences is becoming a finer and finer line. On the other hand, through the process of mutual permeation, some new sciences have emerged on the fringe, related not only to natural sciences and technical sciences but also to social sciences. These include environmental science, ecological

economics, technological economics, archaeology and sociology, artificial intelligence, and social engineering, etc. It would be difficult to categorize them purely as natural science, social science, or technical science. These multi-discipline, multi-area science systems are increasing. This will be the principal direction of future science development.

Currently, the world's major industrially developed countries have begun to closely relate their policies for natural sciences, technical sciences, and economic and social development and consider them on a unified basis in establishing a unified policy. The primary purposes are to improve the economic benefits of investment and strengthen their competitiveness on the international markets. We are a socialist state. Our goals in establishing a unified policy for the three areas of sciences should be: to establish the most advanced, most rational, and most effective socialist economy and society; to satisfy the requirements of a planned and proportionate high rate of development; and to strengthen competitiveness on the international markets.

Our country has not had an organization for the establishment of unified policies for the three areas of sciences. I believe that now is the time to consider this question. Such an organization should consider the following questions:

1. Study the relationship between the three major science areas and our construction for socialist modernization and the relationships between the three areas themselves so that their development will be consistent with national construction;

2. In the area of the magnitude of our scientific enterprise development, study what the proper proportion should be for the development of social sciences, natural sciences, and technical sciences and gradually change the tendency of emphasizing science and engineering and making light of the liberal arts, in order to push forward faster with a balanced unified development and personnel cultivation for all three areas of science.

3. Push for both division of work and cooperation between the research forces in the three major science areas so that a rational arrangement exists in the country and the research strengths in the various areas may be demonstrated to their advantage.

I hope to see early action in this area.

5974
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REFORM OF SCIENTIFIC RESEARCH SYSTEM DISCUSSED

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 2, Apr 1982, pp 71-75

[Article by Yu Desheng [0060 1779 0524] of the Policy Research Laboratory of the Chinese Academy of Sciences: "Several Opinions Concerning Reformation of the Scientific Research System"]

[Text] The current scientific research system in our nation is becoming less and less suitable to the needs of our nation's buildup. This has been observed by all. It requires reform, but where should we start?

The Expression and Reality of Reforming the Scientific Research System

The economic circles have been very successful in reforms marked by expanding their autonomy. Therefore, many comrades in the scientific circles also want to follow suit, and they have called the reform of the scientific research system an "expansion of autonomy." Using the reforms of the economic system as reference to push self-reformation forward is undoubtedly beneficial. But economic activity which is closely linked to the market and which is bound by the laws of prices to a definite degree is after all very different from scientific research (especially basic research), which is inspired more by nature and which explores nature's laws. In reforming the scientific research system, expanding autonomy is also an important aspect, but it cannot become the only aspect and symbol of this reform. This is because certain problems that are deep-rooted and that must be reformed, such as the coordination of subjects, mobility of personnel, socialization of scientific endeavors, often cannot be solved by "autonomy." Therefore, seeking truth from facts, proposing problems like shooting arrows, labeling the reform of the presently unsuitable organizational structures as a reform of the scientific research system may be able to reflect the nature of things more, and this will help guide the efforts towards a correct direction.

Lessons and Methods

There has not been a lack of reforms over the past 30 years, but the lessons and experience vary. How to carry out the reform so that reformation of the system can realize the expected goals? It seems that the following points must be grasped:

1. Academic exploration must be administratively decided. Although reform is urgent, haste makes waste and we must be careful. Before reformation, it is best to discuss it fully. For many years, everyone has extensively explored the reformation of the scientific research system. Certain units have also presented some ideas and carried out some trials. Enthusiasts all have their own ideas on which should be developed, which should be reformed, which should be quickly carried out and which should be delayed. In addition, the scientific research system of foreign nations has been changed many times, and there is historical experience as reference. Therefore, we should develop academic activity surrounding this question: We should survey and study the domestic and foreign situation, summarize historical experience and lessons, compare different ideas and models, and discuss and prove them. On this basis, it is not difficult to draw up several plans for selection and trial implementation. Spontaneous decisions that have not been proven will frequently lead to results contrary to expected goals.

2. There must be experiments. Things that have been proven academically may not necessarily be able to stand up to practical tests, like newly designed products which may very possibly show defects in practical use. Therefore, prior to an overall reform, the plans which are presented for selection must be tested separately, and then they must be analyzed and combined. Their advantages and shortcomings must be compared and even retested. A popular saying states that "a tailor measures seven times but cuts only once." This is the reason.

3. We must allow for many ways. Besides comparing many plans during the experimental stage, official reform must also allow different methods of doing things on the basis of unified general principles. This is not only because each research unit is different from the other in the type of research, it is also because there are different ideas in management methods. We must allow them to compete and to show their advantages and shortcomings in competition, and open up our own road. History has proven that regardless of how large or small the task, if everything is done in the same way, frequently many chances for survival will be killed.

Socialization of Scientific Endeavors

Scientific research must realize socialization to the maximum. Any kind of division of labor means cooperation. Cooperation, even the simplest form of cooperation, will bring about gain unimaginable in singular effort. It can be said with determination that a nation's scientific research work will become a business that is rich in achievements and that is highly efficient only when it is established on the foundation of a high degree of social division of labor. Conversely, if it is managed like a small farm enterprise, and if it scarcely relies on social forces, it will not be possible to have a high efficiency and produce many achievements.

Under present conditions in our nation, the main aspects of socialization of scientific research work should at least include the following:

1. Coordination and cooperation between topics. In foreign nations, some people advocate that certain subjects can be intentionally and repeatedly included in different research organizations to increase the probability of success, hasten its progress and expand its influence. But in our nation, scientific research funds and manpower are limited, and for general subjects this should not be commonly done. Only a few key subjects can be considered for such arrangement and they require unified arrangement. Viewing the current situation in our nation, there are situations in which research personnel are not allowed to select their own subjects but rather, subjects are forced upon them. There are also situations in which subjects are selected at will and subjects are established at will without any coordination. Foreign colleagues often express bewilderment at the massive number of subjects proposed together. This kind of "expansion of autonomy" is not good. In the future, we must allow research personnel to have the freedom to select the subjects (especially basic research) on the one hand, and on the other hand, we must strengthen organization and coordination. This is exactly a manifestation of the policy of "developing the superiority, encouraging competition, promoting unity" in scientific research.

In foreign nations, subjects are registered by an information center (input into the computer), and progress of each phase is reported so that researchers can research and make enquiries. This method is worth learning. Only by exchanging information can we avoid redundancy and blindly establishing subjects, and this also facilitates coordination and cooperation. If our nation can order all research units to obligatorily report the subjects to a certain center, and the latter can report to each scientific research unit, then this method can be accepted. The national administrative agencies that oversee scientific research have the power and the duty to coordinate major subjects (such as important subjects and subjects requiring large investment). Subjects that are not key subjects require only that they be reported, and it is not necessary to strictly coordinate them.

2. Experimental equipment, large instruments and books and information should be shared. Regardless of how large or how expensive the instruments and equipment are in our nation, they are all assigned to the research institutes (even laboratories) for their specific use. As a result, state investment is huge, the rate of utilization of the equipment is low, and frequently the equipment becomes outdated before there is time for it to serve its functions fully. In the West, laboratories have been commonly opened to the society for a long time. Recently, the government of the Soviet Union has also decided to ask each university to establish public laboratories open to the public. These efforts are effective ways to establish high level, high efficient and low cost modern laboratories which have a high rate of utilization. At the same time, they are also an effective measure to develop scientific research. In the future, we should establish some different types of public laboratory facilities (including presently existing ones which can be converted to public use) in some cities where scientific research units are concentrated according to plans. The large equipment that is worth more than a certain value and that has been obtained by the research units themselves should be readjusted or be regarded as being loaned from the state, and they should pay rent, or the equipment can belong to the research units but they must deduct depreciation

from the total funds for scientific research annually. Accounting for research institutes can consider the establishment of accounting for scientific research projects and accounting for single project equipment while public laboratories can sign contracts with research units to charge hourly fees.

Laboratories can be shared and so can books and information facilities or data banks. Our nation's research units are often right next door to each other, but each builds its own library and information systems. This is wasteful. Foreign nations have had school libraries and institute libraries for a long time. Many institutes of the Shanghai branch of the Chinese Academy of Sciences do not have their own library, but utilize the institute's library. The results are good. Facts prove that an institute-wide library is a good method of low cost and highly efficient service.

3. Socialization of logistical support and life services. The time spent by our nation's scientific research personnel in logistics and living problems (such as instruments, material processing conditions, purchasing coal, purchasing groceries) varies according to the differences in local conditions. The time spent for such activities in small towns even surpasses the time for scientific research, and for the scientific research backbone personnel, the time spent for such activities is much more. People have long noticed: Among the several people similarly talented and hard working, frequently those who remain abroad have outstanding achievements while those who have long returned have made little achievements. Besides the conditions for experimentation and information exchange, logistical support for research is poor, and spending too much effort on making a living is frequently the main reason. If we can organize a scientific research instruments service company and a living service company, we can save a lot of precious time for scientific research personnel. This is the same as increasing the number of hard to find scientific research personnel. To provide living services for scientific research personnel, the fees should be low and there should even be subsidies. This is because the income of most scientific research personnel is very low. Otherwise, we could not afford to hire them. Practice will prove: It may seem that what we have grasped is an insignificant thing, but it will serve a function that is far from expected. This is like Lenin, who inquired about the food fed to the dog used in the Pavlovian experiments and about the conditions in the Zelinsiji Laboratory. It far surpassed the superficial significance.

Of course, the question of socialization not only involves the above aspects. The socialization of scientific endeavors presupposes a high degree of specialization. It opposes natural economic methods. Its fundamental advantage is that it can centralize within a specialized agency the work of the same nature but managed separately in a scattered manner by many units. Therefore, it can produce a higher efficiency, a higher technical standard and a better quality of service at a lower cost. Therefore, all endeavors which can be socialized (this also means specialization) should be socialized.

Scientific Exchange

Science is a business of manufacturing knowledge, while knowledge is expressed by information. Therefore, we can say that science exists in exchange. With-

out exchange, even existing knowledge will be dead and new knowledge will not be produced. Therefore, exchange is the spring of life of science.

There are many forms of exchange. Publication of theses and reports (including conferences) is a fundamental method. Besides this, the exchange of personnel frequently has a special function that cannot be replaced by other forms. Many known scholars, especially Nobel laureates, have pointed out that when they worked under famous scholars, it was not how much knowledge that was taught but the ability to take charge of the direction and to capture major problems learned from them, the stubborn self-confidence and self control and the good style of scientific research... This cannot be taught through reading documents and conducting scientific discussions. From the 1940's to the 1950's, America's science and technology developed prosperously because they profited from the large number of European scientists who came to the United States and because American scientists before the war learned and worked at most of the famous European laboratories. Because of this, today's European and American scientific circles all oppose "self propagation" in science but advocate "hybridization," and they have formed a system: Graduates do not stay at their own school to work. Schools or research agencies encourage their own people to go elsewhere to work and they take in people from other units. The Japanese originally practiced lifetime service at one unit. The greatest shortcoming of this system of a rich Oriental flavor is now felt to be that ideas easily become rigid, and change is sought.

The system practiced for many years in our nation is basically that of the scientific research personnel staying at one unit "from the beginning to the end." This is a reflection of the conscience of feudal agricultural economy in scientific endeavors and it very easily causes thoughts to become rigid. The new superseding the old in personnel is not active, and there is a lack of vitality. The main problem at present is to relax the confinement of personnel, stimulate exchange, and change the policy of "locking our own doors," Exchange of personnel involves simply this: For the individual researcher, he can go to other units to work for a short period or for a long period. For the research institute, it should have the authority to select and hire or dismiss its own workers. This requires revising the present personnel system and implementation of a labor contract system: According to contract stipulations, both sides should carry out their duties. As soon as the contract is fulfilled, both sides can free themselves from further obligations.

Expanding Autonomy

The shortcomings of overcentralization and overly tight centralized control have seriously affected the healthy development of scientific endeavors.

First, in the authority over personnel, the responsible persons of all institutes, and especially the research laboratories, do not have the authority to select their own team. Frequently, the decision to hire or not to hire a person and to match the "bound couples" is in the hands of those who are not in charge of business. Scientific research work is different from productive labor. The requirement for coordinating and supplementing thoughts, opinions, methods, understanding and cooperation in work is high. These special

qualities cannot be solved by the personnel lists and cadres' files. This problem can only be solved well if the authority to select personnel is handed over to the organizers of scientific research work. Therefore, a better method at present is to implement the policy of letting the agencies of higher authority control the number of personnel, the funds and personnel policy while the hiring and dismissal of personnel are handed over to the research institutes. Within the institutes, the "responsibility cabinet system" can be implemented, i.e., the leadership of the institute can organize the research laboratory and group personnel according to the research task and assign persons in charge. The person in charge can select his own helpers to be approved by the institute. Of course this means that the source of manpower must be guaranteed and that unneeded personnel will have an appropriate place to go, otherwise, the talk of personnel exchange and the new superseding the old in personnel will be empty talk.

The second is financial authority: At present, finances are controlled too tightly, and this is not favorable to mobilizing the enthusiasm of the lower echelons. Of course we should strive towards reducing state expenditure, but this alone is not enough. The establishment of a financial system should benefit the realization of the main goal of scientific research agencies: the completion of more scientific research work of higher standards. For this, it seems that there are several principles which should be implemented in the reforms:

1. Investment at different levels for scientific research projects should be implemented so that the key issues of the overall situation can be guaranteed and the enthusiasm of the basic levels can be fully developed. The key projects of the state and of a certain major sector must be reviewed and budgeted by higher authorities. Their budgets must be determined and funds should be appropriated in different years (some nations have already changed this to loans and final accounting, and this can also serve as a reference). In addition, the institutes can also set up a scientific research fund to pay for scientific research projects approved by the first rank authority of the institutes. The scientific research funds of the institutes can be determined by the number of people and past work achievements, but the total amount of the scientific research fund of an institute must be linked to the achievement of the work accomplished, i.e., the more work accomplished and the better the work accomplished, the more directly appropriated funds a project can obtain. Therefore, there will be a greater possibility to develop work that one believes is significant. This creates a snowball effect: The units that produce more outstanding work will have more possibility to independently develop some hopeful work. Greater possibilities will be obtained because of such work,..., and the cycle continues.

2. Workers' salaries (not limited to wages) must be linked to the quality and the quantity of the work accomplished by the institutes. For this, we must establish a related system, establish corresponding organizations and systematically evaluate the work of each link and every person. We can refer to the experience of the industrial departments without violating the national wage system to provide internal wages and link the variable part of personal income, such as rewards, percentages of various cash income and non-monetary benefits (such as housing, vacations) to scientific contributions.

3. Separate management and separate economic accounting should be implemented. Financial management of basic research and applied research should be differentiated. Scientific research funds should be classified according to investment, the amount of appropriation and separate balances to facilitate inspection of the results and to calculate costs. Within legal limits, commissioning units that commission certain research projects that have a strong nature for application (party A, also including higher authorities) should sign contracts with scientific research units (party B) to establish the financial responsibilities of both parties, and appropriation of funds by party A (commissioning party) according to contract can also be considered. Funds left over are not returned (party B can keep the unused portion) and shortage of funds are not subsidized (party B is responsible for extra expenses). The equipment owned by each scientific research unit, specialized experimental units and computing units should be made available to the public, and services provided should be paid for. A portion of the additional income from high quality services and improved rate of utilization of the equipment should be under the discretion of the unit itself for use in expanding business or for collective welfare. The rest can be used as monetary rewards to workers.

Distribution of Scientific Research Agencies

In the question concerning the distribution of scientific research agencies, such a viewpoint was once popular. It seemed that the more scattered they were the better, and the more remote their site the better. Of course, we cannot concentrate all of the nation's scientific research agencies in one or two cities. And besides, the nature of some units determines their locality of work (such as oceanographic studies, the study of tropical plants, the study of salt lakes). But generally speaking, if there are no special limitations in geographical conditions, research agencies should be distributed according to the principle of being scattered broadly and concentrated in small numbers. This means, nation-wide, there should be several scientific research centers (cities), while within each locality they should not be overly scattered and should be concentrated as much as possible.

When establishing research agencies, we should follow regional centralization or the method of building cities of scientific enterprises. These methods have many advantages which cannot be neglected.

First, large laboratory facilities, computer stations and libraries can be shared, and this is favorable to socialization of scientific research.

Second, this is favorable to socialization of living services, such as building various service enterprises (child care centers, mess halls, family life services). If the distribution is overly scattered, these types of businesses will be very difficult to establish, and problems in living will necessarily take away the energy of research personnel.

Third, this benefits academic exchange and cooperation. Having research personnel who can live next door to each other, or who can converse after meals or visit each other after work will halp exchange views and provide mutual encouragement. Many ideas and views are formed in such conversation. Because

the institutes are close to each other, interdisciplinary cooperation and academic exchange can be more easily organized.

Fourth, this benefits the development of talent. The regions where scientific research agencies are concentrated easily produce talent among workers or their dependents because of the research atmosphere and the encouragement of academic thought.

Because concentration has so many advantages, many nations have established science cities. For example, Japan's Tsuha Science Town is reported to have more than 20 scientific research units and higher educational institutions. The New Siberian Science Town in the Soviet Union now has 56 research institutes, and it has become one of the most important scientific research bases in the Soviet Union. According to Soviet reports, the Siberian Branch based in the New Siberian Science Town is the branch with the highest efficiency and the greatest achievements among all branches of the Soviet Science Academy.

Division of Authority and the Establishment of a Supervisory and Regulatory System

Many years of experience have proven that overcentralization of authority is dangerous to political authority and the economy, and it is unsuitable to scientific endeavors.

Last May, the fourth meeting of members of the Academic Department of the Chinese Academy of Sciences passed the "trial charter of the Chinese Academy of Sciences." It clearly separated the authority of the power holding agencies (the council of the academic department and the presidium) and the executive agencies (director of the academy and its leading agencies). It has provided a model for the direction of reform of the scientific research system. It will serve greatly in pushing forward future reforms of the system.

No system can be perfect and without shortcomings. They key is to establish a system that can prevent or correct at any time all possible flaws--a supervisory system. The more authority the basic levels have, the more important this problem becomes. When Lenin was on his death bed, one of the major problems that he never forgot was the establishment of a strong and powerful supervisory agency. The unfortunate history of the Soviet Union, especially the acts of stepping over the legal system and destroying science from the 1930's to 1940's proved that Lenin's worries were farsighted. Therefore, it can be imagined that the system of scientific research agencies in the future can generally be: separately established independent executive agencies, supervisory agencies and academic evaluation agencies under the power holding agencies within the scientific research agencies.

The executive agencies are the administrative agencies in scientific research. They are responsible for carrying out the laws of the state, policies and decisions of the power organs of the unit itself, and they exercise daily management in organizing and coordinating scientific research work. Supervisory agencies are responsible for supervising the executive agencies at each level in implementing applicable state laws, policies and decisions of

the power organs of the unit itself. They can suggest ways to handle personnel who have made mistakes, and guarantee the proper rights and benefits of the workers. We must emphasize: only if the supervisory agencies are independent of the executive agencies can they avoid becoming a satellite and can they effectively perform their own duties. Therefore, in the organizational system, they are directly subordinate to the power organ, and they should form their own system under the leadership of higher supervisory agencies. A strong and forceful supervisory system is like the immune system of the human body. It is a forceful guarantee of the health of a system. Academic evaluation organizations should be advisory agencies with an independent position. They can make independent judgement and evaluation of related academic questions. Of course, the power organ or the administration may not completely agree or accept the evaluation, but discussion and judgement by the academic agencies free from interference should be the necessary prerequisite procedures and bases for the latter two types of agencies to take action related to academic questions (such as the drawing up of plans, the determination of major projects, signing of contracts, evaluation of achievements, delegating authority). The division of power is very complex and it should be carefully discussed and studied, and corresponding rules should be stipulated. Under such a structure where authority is divided while centralization is still guaranteed, generally speaking, major unexpected mistakes can be prevented. When deviation occurs, it can be easily corrected.

9296
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BUILDING UP QUALIFIED TECHNICAL MANAGEMENT PERSONNEL URGED

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[Article by Dai Zhenhai [2071 6966 3189] and Wang Miaoyang [3769 8693 3152] of Fudan University, Shanghai: "Accelerate the Build-up of Technical Management Ranks Through Intellectual Investment"]

[Text] The management of modern science and technology is in itself a science. It is the management of science and technology according to the laws of development, and its characteristics, and the most effective use of manpower, money and material. It is an important guarantee for rapid development in science and technology and for the improvement of the productive force. In a certain sense modern technology and scientific management are the two driving forces behind the progress of a modern society. International economic competition after all is competition in the speed of development of technology and the quality of management. Therefore, when we indulge in the modernization economic construction, we not only should pay great attention to the role of technology but also have a thorough understanding of the great significance of strengthening technical management and the training of management personnel. The construction of a specialized, technical management team is an urgent task in the promotion of science and technology development and the improvement of the party's leadership over technology.

1. A common experience of successful developed nations is the emphasis of building up a specialized, technical management rank. The successes of rapid economic development of many nations after World War II are all due to emphasizing systematic and purposeful training of management personnel.

The history of technology and economic development of the United States is a process of continuous improvement of intellectual investment on the management rank. After the war, the technological and economic development of America, a nation established less than 200 years ago, has far exceeded that of Europe with its long history. In analyzing the causes for their lagging behind, the Europeans believe that the difference is in management rather than in technology. Over a half century, the United States has formed a huge network of management colleges and trained a large number of management specialists. As early as 1881 the University of Pennsylvania first established its business college and trained largely junior level management personnel. American

President Hoover advocated in 1920 that: "America's great need in manpower in the future will be political talents with leadership ability in the area of economics." At the urge of this alumnus, Stanford University established its institute of business management in 1921 and in the 50 years thereafter trained about 10,000 senior management talents. Many other universities have also established colleges devoted to the training of management personnel and the most famous one is at Harvard University. One-fifth of the high level management and leadership people in 500 largest American companies are graduates of Harvard University. According to 1977 statistics, out of 284,200 senior technical staff with doctoral degrees in America, there are 66,500 management doctorates, or 23.4 percent of all Ph.D.'s. Almost one in every four Ph.D.'s are in management, this shows the high demand on the specialization of management people. According to a report by the American Education Statistics Center, today there are 1,156 universities in America that have business colleges and the total number of undergraduate students is 900,000 or, 15 percent of the total number of university students. Technical manager of the Manhattan project in the 1940's, 38-year-old physicist Oppenheimer concluded that "scientific organization and management allows science and technology to develop its full force." In the 1970's, Apollo project leader Dr Weber also said: "There is not one technology that we use that other people don't have, our technique is scientific organization and management." These examples show that, in the creation of these epoch-making technological achievements, "scientific organization and management" played a major role.

After Russia began its large-scale economic construction, they also placed relatively heavy emphasis on the training of technical and technical management personnel. By the early 1950's, several million cadres had received higher and vocational education. They had a slogan: "learn from Harvard." In 1960's, Soviet Union devoted considerable manpower and money toward scientific research, research investment expenditure reached 2-3 percent of their gross national product and the number of staff in research departments jumped to fifth place, next only to industry, agriculture, construction and transportation. Under those circumstances, the development of modern science and technology was required to shift from quantitative increase (increase in manpower, finance and material inputs) to qualitative improvement (largely improvements of organization management and senior research training). From then on the Soviet Union stressed the improvement of technical management and quality of technical management personnel. Today there are more than 1 million people studying management in 50 universities in the Soviet Union. Management cadres at all levels are required to study at management universities and their regulation also requires retraining in a few years.

2. Upgrading the management cadre ranks is an important measure in speeding up technological development during the readjustment period and is an urgent task to be solved now.

For now and several years hereafter, the Chinese economy faces a period of readjustment. In this period the economic development will shift from an external expansion to rely on internal improvement. Science will play an increasing role in economic development and the application of research

results will more and more affect the rate of economic and social development. Therefore, the primary question we face now is how to use effectively the resources devoted to science activities. This requires a corresponding system to improve the efficiency and quality of science management and activity. In other words, the emphasis should be on the qualitative improvement of technical management and not relying on the quantity of manpower, money and material devoted to science. It was reported that in Norway during the 55-year period of 1900-55, production increased 0.2 percent for every 1 percent increase in fixed capital, production increased 0.76 percent for every 1 percent increase in labor force but production increased 1.8 percent for every 1 percent increase in trained management staff. This shows how important management improvement is. The key to management improvement lies in the quality improvement of the management rank, the rank must be specialized if the management is to be scientific. Strengthening the specialized technical management rank and improving the quality of scientific management are indeed urgent tasks in the readjustment period.

Judging from the actual situation in China today, one might say that technical management is even more underdeveloped than technology and the shortage of technical management talent is even more serious than the shortage of scientific and technological talent. The conflict between the modernization demand of science and technology and today's underdeveloped technical management is becoming increasingly acute. We now have the following prominent problems regarding the construction of a management cadre rank:

The first problem is the lack of specialized knowledge and vocational training of the present management cadres. A survey was made last year in 80 research institutes in a certain city, among 303 institute level leadership cadres there were only 20.6 percent technical and management staff who are knowledgeable about the specialty, as many as 66.3 percent of them have a culture level below the intermediate level. In a survey last year made at 2 bureaus in a certain city, less than 10 percent of 266 cadres above the section chief level had management training or college level education. Even in units with relatively high culture level, management cadres also lack management training. At one university in Shanghai 90 percent of 146 cadres at the section chief and commissioner level had college level education but no management training. Two-thirds of them are not familiar with teaching management and technical management, three-fourths of them are unfamiliar with the history of natural science and five-sixths of them do not understand computer technology and scienology.

The second problem is caused by the long-term interference by the leftist thought and "laymen directing the experts." Consequently, there has been no specific requirement and regulation regarding professional and educational background of technical management cadres and the training of technical management specialist was looked down upon. In the early days after the founding of the People's Republic there were still some management colleges and departments but they were later gradually phased out. A great majority of the management graduates in the 1950's from some universities were assigned to jobs unrelated to their specialty, some systems trained several thousand management graduates but had no positions to assign them to and almost all of them

have switched professions. In other countries, due to the management need in the 1960's, management specialty had the largest number of students and the fastest growth. That period was therefore known to some as the "age of operation and management." But we have paid almost no attention to the training and use of management graduates. Because of the lack of specific requirements and regulations on the professional and educational background of management cadre, some technical departments increased nontechnical administrative staff in great numbers and such incidents continued to occur even during the past 2 years. Technical management cadres should not only understand the basic knowledge of their technical specialty and economics, but should also possess fundamental knowledge of technical management, understand the special features and general rules of science and technology, be familiar with the party's technology policy and have a certain ability for organization. We cannot equate party and political cadre to technical management cadre and we cannot equate technical specialist to experts on technical management. For a long time we have not been treating technical management as a science and have paid little attention to the specialization of a technical cadre personnel, today most technical management cadres--including some old cadres and some new cadres with college educations and technical titles but new in the profession of technical management--to some degree are laymen in technical management and they all face the problem of learning the knowledge of technical management and knowledge renewal.

The third problem is that the policy of intellectuals in the technical management rank was not put on solid basis. Unification of the professional title in management was slow, the ranks were unstable and for a long time promotion was slow and salary was among the lowest of intellectuals with equal qualifications. If this situation is not corrected quickly we cannot expect them to play a full role and possess high efficiency in management even with relatively good equipment and an advanced facility.

3. To a large extent the quality of management depends on the quality of management cadres. In order to rectify the underdeveloped situation of technical management in China, the pressing obligations, besides continuing to improve ideological awareness and overcoming the influence of the erroneous leftist thought, are to take effective measures in intellectual investment as quickly as possible, establish the necessary policies and put them on a solid basis and make a great effort to establish a specialized rank of technical management. To this end, we have the following recommendations:

(1) Based on the requirements of the specialty, personnel departments should institute specialty requirements and management methods of technical management cadres at various levels and of various types (overall management and job management). In the future, the addition of management cadres should be made after a training based on the requirements of the specialty. Special attention should be given to those cadres who are solidly behind the party line of the 3d Plenum of the 11th Party Central Committee, enthusiastic about the enterprise of science and technology, familiar with intellectuals and of high integrity to do the job of managing technical management cadres.

(2) We must actively and steadily improve, strengthen and adjust the current management rank and rectify the current personnel structure and knowledge structure.

Of the many management cadres currently available, most of them have relatively rich practical experiences but lack the knowledge of modern science culture and scientific management. Forceful measures should be taken to train them in shifts. According to different cases, we should actively help them learn the technical profession and the fundamental knowledge of economics and management science, then select and train a group of cadres who are in their prime years and who basically qualify as to professional requirements and make them the backbone of technical management force at different levels.

In the meantime, we should attract a group of talented management experts (or specialists) to strengthen various leadership posts and important management departments. The tendency to neglect management knowledge and ability should be avoided in the selection.

In addition, qualified institutes of higher learning should actively assume the duty of training management talents, organize business management colleges and departments and cultivate a new generation of management manpower and vigorously develop management science research.

Through efforts in the areas discussed above, we should strive to nurture and cultivate a large number of management specialists in the next several years who are familiar with the Chinese situation and know the management profession.

(3) In an overall plan, we should thoroughly conduct training of technical management cadres currently on the job. A national technical management cadres' training program should be formulated while keeping in mind the requirements of enterprise development and building up a professional management rank. The target for training at various levels and the number to be trained, the progress and standards should be determined according to the management jurisdiction and type of business of the cadres. Division of work and responsibilities should be arranged in a coordinated fashion and the aim should be for one round of training for all the technical management cadres within 3 to 5 years.

The training of technical management cadre has received wide attention by various ministry committees and provincial and municipal science committees. Most provinces and municipalities have already conducted 1 or 2 semesters of class study and obtained some results. The outstanding problem now is that most provinces and municipalities do not have fixed training bases and lack professional teaching staff and material suitable for our situation. There is also a shortage of special organizations and resources to study how to conduct this training education. If this situation persists, it will affect the result of cadre training. We therefore recommend the establishment of national and local technical management cadre training bases. Independent colleges for technical management cadre improvement may be instituted or training points may be set up with collaboration between the science committee system and relevant institutes for higher learning to overcome the current make-shift situation in cadre training--just before training is to be conducted, a place is borrowed, a teacher is found, notes are mimeographed and a sign is put up. Cadre training has certain special requirements and should

satisfy the needs of the trainees, they not only need to study basic knowledge and theory but also to investigate real problems and learn how to apply the training. The training standard should be rigorous in order to maintain quality.

In order to speed up training base installation and the management profession, a teacher pool consisting of college teachers, management cadres and research staff should be formed, the writing of teaching material and basic reading material consistent with the Chinese situation is also a pressing need. National training centers for professional teachers of technical management should be established and these professional management teachers should be concurrently appointed to do management work or to participate in technical management consulting. Different workshops should be held and a major effort should be made to consolidate our own experience in technical management.

(4) Policy on technical management staff should be studied and gradually perfected and finalized. In the selection of superior management cadres we should adopt a policy that treats them politically favorably and economically no worse than technical staff of equal qualification. In considering the salary of the management cadres, job title, rank and seniority should be taken into account. Evaluation of technical professional titles of the management cadre should be conducted carefully and their effort to improve their own professional management ability and quality should be encouraged so that management personnel at all levels have a definitive direction for their effort, and initiative can be fully developed and high efficiency of management assured. Participating in overall management and engaging in management research are both avenues for advancement for management cadres. Special attention should be given to the training and selection of overall management talents, a method combining training and selection should be employed systematically to select candidates for overall management from professional management cadres. Direct evaluation to general management posts of professional personnel without management specialty experience should be prevented. Efficiency consists of three factors: initiative, encouragement and competition. Encouragements should be given to those with prominent achievements and contributions. A system of regular and periodic training and evaluation is also needed. In the professional evaluation of management cadres, appropriate examinations on basic knowledge should be given to new workers and the evaluation items for management cadres with academic degrees or many years of experience should largely include work results and management efficiency and whether their recommendations based on investigation research were adopted and what results they produced. Evaluation methods separated from job results and efficiency are undesirable and will not have a positive effect.

An important mission on the technological front during the readjustment is to make wise intellectual investment and to speed up the construction of a professional technical management personnel. If our various party organizations and departmental leadership attach great significance to this mission and take effective measures to organize training, build up the personnel, improve professional quality and carry out the policies, then, after some years, a qualified professional technical management team will be playing an active promotional role in the economic development and technological enterprises of China.

9698
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CURRENT POLICY AND MAJOR MEASURES IN THE MANAGEMENT OF SCIENTIFIC AND TECHNICAL PERSONNEL

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[Article by Ai Dayan [5337 1129 3508] of the Scientific and Technical Cadres Bureau of the State Council: "Policy and Major Measures of Managing Scientific and Technical Cadres"]

[Text] According to the political line, the guiding principle and the policy of the Central Committee, we can summarize the concrete guiding principles, policies and major measures of managing scientific and technical cadres currently being implemented in nine aspects.

I. On the Basic Policy of Management of Scientific and Technical Cadres

First, we must thoroughly implement the Party's policy concerning intellectuals. The Central Committee has instructed us many times: "Our nation's broad number of scientific and technical cadres includes most of the scientific and technical cadres from the old society. After a long period of training and education by the Party and during the movement of the Three Great Revolutions, they have become a part of the working class, and they are exerting efforts and self-consciously serving socialist endeavors. They are the forces which the Party relies upon, and they are the treasures and wealth of the Party and the nation." The key points in this statement are as follows: First, we must recognize that the broad number of scientific and technical cadres of our nation includes most of the people from the old society and they have already become a part of our working class. They are the forces which the Party relies upon. Second, we must recognize that science and technology are the keys to realizing the four modernizations. These two points are the starting points of the basic policy of our efforts to manage scientific and technical cadres. If this question is still affected by leftist ideology, then the cadres will not be managed well. The Central Secretariat made the following basic evaluation of the work concerned with the present team of scientific and technical cadres: After fall of the "gang of four," especially since the 3d Plenum of the 11th Party Congress, the position of scientific and technical work has been elevated, but it has not risen to the height it should have. Up to now, many comrades throughout the Party still do not clearly understand the importance of scientific and research itself, in the popularization of scientific

and technical achievements, and in the use of scientific and technical cadres. Because the neglect of science and technology among some cadres has been formed over a long period, therefore solving these problems cannot be too hasty. To enable comrades of the whole Party to improve their understanding of scientific and technical work, we must first improve the understanding of the leading cadres at each level. The Party committee at each level must include scientific and technical work in the daily agenda of important business. It must use facts to educate everyone so that people will truly believe that science and technology have already served a great function in socialist construction. Is our nation's team of scientific and technical cadres a part of the working class or not? Why do we say that it is a part of the working class? We can explain this by analysis: Our nation's team of scientific and technical cadres consists of 5.29 million people, including four groups: The first group includes those who were trained in the liberated areas before and after the period of resisting Japan and those who were sent to the Soviet Union to study. The second group includes those remaining from old China. The third group includes those who risked their lives by returning from Western capitalist nations at the beginning of the founding of the nation. The fourth group includes those trained by ourselves over the past 32 years since founding of the nation (including students sent abroad), constituting about 90 percent. The first three groups have been trained and educated for many years by the Party and have made a lot of contributions. Students sent abroad by us mostly studied sciences and engineering and medical sciences. These people are the backbone forces at their posts. In treating such a scientific and technical team, can we still doubt that they are not our own people? In general, recognizing that scientific and technical cadres are a part of the working class and that they are the forces which the Party relies upon should be the most fundamental guiding ideology for all of us who are involved with scientific and technical cadres.

The Central Committee pointed out: science and technology are the key in building the "four modernizations." The reason underlying this question can be explained originally in theory by Marxism-Leninism and in practice and experience. But some comrades still have an insufficient understanding today. Everybody knows that according to statistics, in internationally developed nations, 50 to 67 percent of the achievements among the factors of their economic growth relied upon progress in science and technology. This means that economic development brought about by progress in science and technology constitutes about 70 percent. In many nations, some products are renovated and replaced every 5 to 10 years. For example, fifth generation computers have emerged. Only some 30 years have passed from the emergency of the first generation (1945) computer up to the present. From the advent of the electron tube, the transistor to integrated circuits and from large scale and small scale to integrated electric power, scientific and technical development has continued to renew and replace each predecessor and the generation changes. This shows how great the function of science and technology is in economic development. They can be directly converted into a productive force. They enable products to be renewed, replaced and sold, and they bring about a large scale development of the national economy. Science and technology are the foundation of our socialist development. Science and technology can be directly converted into a productive force, and productive forces are the

fundamental conditions for pushing social progress forward. Stalin said: "The fundamental economic law in a socialist society is to use methods of continual development of production on the basis of a high degree of technological development to satisfy the continually increasing material and cultural needs of the broad masses of people." His emphasis was still on the prerequisite condition of "a foundation of a high degree of technological development" to explain that science and technology are the key.

During the period of readjustment, the Central Committee has emphasized repeatedly that we must mainly rely on the efforts of existing enterprises to develop potential, to carry out renovations and improvements. This requires fully developing the enthusiasm and creativity of scientific and technical personnel.

Comrade Zhao Ziyang once said: "Development of the national economy must rely on science and technology. Science and technology must serve the national economy. Now, the problem is to practically develop the function of science and technology so that they can truly become the great forces in improving economic results and promoting economic development." These statements explain the relationship between science and technology and the development of the national economy very clearly. Science and technology should develop with the economy and society in a coordinated way, and promotion of economic development should be the foremost task. Here, I want to introduce some information regarding the United States. The information analyses six reasons why American science and technology lead the world, and these are six necessary conditions.

First, every sector of society has a relative recognition of the important function of science and technology. The government has passed legal means and has implemented various policies and measures to protect the development of science and technology.

Second, there is sufficient scientific research funding.

Third, education is developed to train scientific and technical talent and attention is paid to developing the function of scientific and technical personnel in scientific research and production.

Fourth, the massive market capacity has opened up a broad world for application of scientific and technical inventions and achievements. This is an important factor that has stimulated the development of American science and technology.

Fifth, military science and research are not only emphasized, relatively more attention has been paid to the mutual "transfer" of military technology and civilian technology, thus American military science has been pushed to the fore of the world. At the same time, the development of American civilian science and technology has been pushed forward by a definite degree. When civilian and military science and technologies can be mutually transferred, civilian factories can be converted to military use when necessary, and military factories can be converted to civilian use during peace time.

Sixth, the United States has always paid more attention to management science, and for a long period, it has gradually formed a relatively systematic management method in scientific and technical management.

The heart of these six aspects is that they emphasize the important function of science and technology in developing the economy and national defense buildup. We can learn from this. Of course, the United States is an imperialist nation. It plunders foreign lands and exploits domestically. This is not compatible with the goals of economic buildup of socialist nations, but we can utilize the advantages of some of its successful methods.

II. Basic Requirements for Scientific and Technical Cadres

Scientific and technical cadres must support the leadership of the Communist Party, they must love their socialist motherland, they must insist on upholding the four basic principles, they must actively serve socialist construction, they must work and study hard, they must grasp advanced science and technology, they must exert efforts to climb the peaks of science and technology, and they must contribute to the realization of the four modernizations. These are the basic requirements of scientific and technical cadres, and generally speaking, they have to be both Red and expert. The first half talks about being Red, the latter half talks about being expert. The question of the relationship between being Red and expert, I believe, should be as Comrade Deng Xiaoping said: "Being expert is not the same as being Red, but being Red must be expert." Saying that being expert is being Red is not correct. Being expert does not mean being Red. Being Red is a requirement of political ideology. It means to support the leadership of the Communist Party, to love socialism, to insist on upholding the four basic principles, and to actively serve socialism. But being Red must be expert. If a cadre wants to serve the people but commands blindly in actual work, does not do things according to regulation, and acts contrary to economic laws and science, then he is not a qualified cadre. To serve the people, one must have a definite ability to build socialism and one must have some true capabilities. If a leading cadre always speaks unprofessionally, does unprofessional things, uses nonprofessionals, and always acts inconsistently with objective laws, I believe he is not a good leader. We must continue efforts to change the nonprofessional to a professional. I feel that special emphasis must be placed on upholding the four basic principles. In the final analysis, it is a question of establishing the proletariat world view and the core is to insist on party leadership. Without the leadership of the Communist Party, there will not be a socialist road. Without upholding proletariat dictatorship, there will not be socialism. The practice of the Chinese revolution proves that Marxism-Leninism and Mao Zedong Thought are our nation's guiding ideologies. Therefore, scientific and technical cadres must learn the basic principles of Marxism-Leninism well and unswayingly uphold the four basic principles.

III. Academic Guiding Principles and Policies

We must thoroughly implement the guiding principle of "let a hundred schools contend," and insist on the principle that practice is the only standard of

examining truth. We must break superstition, liberate thoughts, develop democracy, encourage free exploration, mutual respect, unity and cooperation among people of different academic schools and holding different academic viewpoints. The question of right or wrong in academic pursuits and different opinions can only be solved through free discussion and scientific practice. We cannot use administrative means to draw conclusions. We must guarantee that everyone has the right to criticize, retort and hold opinions. Even if one's academic viewpoint has been proven wrong by scientific practice, we must not accuse him by giving him a political label. This is the basic guiding principle concerning academic questions.

The task of natural science workers is to understand nature and improve nature. The so-called understanding nature is to study and explore and discover objective laws of nature. Understanding laws of nature requires a course of exploration, and there is a process of accumulation which is also a course of continued and deepening development.

In the long river of development of things, all truths in a particular stage of events and under definite conditions are relative truths and are not absolute truths. These truths are only proven to be real and accurate under a definite condition. But, further in depth study along with the development of other objective conditions makes understanding more profound and there will be new discoveries and new laws. Because the development of objective things is limitless, therefore the development of people's understanding of nature will never end, but will approach absolute truth step after step. This is what Marxism-Leninism calls the dialectic relationship between absolute truth and relative truth. Such examples abound in the history of development of natural sciences. Therefore, developing democracy and letting a hundred schools contend seem to be very important in the realm of natural sciences. As Chairman Mao said: "Human history is a history of continued development from the realm of necessity to the realm of freedom, and this history will never end."

IV. Guiding Principles for the Distribution and Utilization of Scientific and Technical Cadres

We must thoroughly implement the principle of consistency between learning and application and the use of strong points. We must arrange things uniformly and equipment facilities in a key way according to the needs of national economic buildup and the needs in the development of scientific and technical endeavors. We must implement the policy of combining planned distribution and employing superior candidates and prevent a waste of talent. In distribution and employment, the main problems that exist at present are the stifling of real talent, suppression of talent, using people not trained in the discipline and using people who are not proficient in the tasks. Our guiding principle is to make learning and application consistent and to employ people skilled in the task. But in view of the present situation, to achieve this requires a lot more work and some problems in ideology and in the system must be solved. A main fault at present is the "unit ownership system" and the "life time duty system." After a scientific and technical cadre is assigned to a post, he can never move again and he can never be transferred. Some units tell scientific and

technical cadres: "This unit of ours only allows you to enter but prohibits you from leaving." Some units are "places with three generations under the same roof." The teacher of one academic school teaches his students, and his students teach the next generation of students. Some people call this "inbreeding" and this is unfavorable to scientific development. The method of hybridizing different academic schools is good, and it is called "distant cross breeding." Different schools of thought must learn each other's strong points to make up for shortcomings, study together, and allow a hundred schools to contend. This is beneficial to academic development. In some nations, schools send their graduates to other places to work first for a while and then allow them to return. We must change the situation of having pools of dead water and the lack of mutual exchange, and we must also prevent liberalization as in capitalist nations. In capitalist nations, "everything is oriented toward money." One goes to wherever more money is offered. You undermine my foundation and I undermine your foundation. We must never learn the liberalization in capitalist nations. Now, some people have criticized us as a pool of dead water. On the one hand, they advocate complete liberalization like capitalist nations. We cannot do so. We cannot advocate free mobility. This is not the policy of our socialist nation. At present, the talented people who have been stifled and who have been wasted generally have true talents and real knowledge. They have the strength but they cannot utilize it. They have gradually wasted away what they have learned, and they have gradually changed from a professional to a nonprofessional. Everyone knows, because the development of natural science changes with each passing day, according to a Japanese saying, if research does not continue for 5 years, then 50 percent of the original knowledge will be out-dated and will have to be abandoned. If one does not learn in ten years, the percentage of knowledge that is out-dated and that has to be abandoned will be 100 percent. Professionals will become nonprofessionals. As we have frequently said, "learning is like navigating a boat against the tide, if it does not progress, it regresses." Some units have talented people who are not being used. And yet they cannot be transferred elsewhere. They say this is "reserving talent for future use." On the one hand, talent is lacking and on the other hand, talent is left unused. This situation must be appropriately solved.

V. The Basic Attitude in Treating Scientific and Technical Cadres

We must fully trust scientific and technical cadres, employ them with a free hand, make strict demands and help them enthusiastically. The leadership at each level must respect science, actively support their rational suggestions and creations and inventions. The opinions of scientific and technical experts regarding major projects of socialist construction and major scientific and technical measures must be solicited, and scientific and technical experts must be organized to propose scientific proof and technical plans before decisions are made. We must guarantee that scientific and technical cadres, especially those in charge of technical management duties, have duties and authority and responsibility. Those scientific and technical cadres who have complex family and social relationships and who are marked by political and historical problems should be assigned work according to their own basic political attitude, their actual performance and their contribution to socialist construction so that they can develop their strong talents. The

basic attitude in treating scientific and technical cadres is summed up in these 16 characters: "trust them fully, employ them freely, make strict demands, help them enthusiastically." These include political ideology, work demands, training and education. life benefits and welfare and many aspects. First, we must recognize that they are a part of the workers and they are the forces that the Party relies upon. Some people have said that scientific and technical personnel "can be employed but not relied upon" and that they do not matter. This is pure utilitarianism. If you do not trust someone, do not employ him, if you employ someone, do not distrust him, if you employ him, you should trust him. When deciding major projects, expert opinions must be listened to. Now, the Central Committee is emphasizing that the leadership at each level should invite scientists to serve as advisers and it should organize counselor corps and adviser groups. They should be invited to present arguments and proofs of scientific and technical problems and propose plans. When employing scientific and technical cadres to serve as advisers or as leaders, we must guarantee that they have duties and authority and responsibilities. This means to give them fixed duties, fixed authority and fixed conditions and to make them shoulder definite responsibilities. In the future, we must establish a strict responsibility system. When the task is not completed within the scheduled time, they must be responsible. The Temporary Regulations for Evaluating Engineering and Technical Personnel issued by the State Council emphasize two stipulations: One stipulates that the criteria for evaluation is based on only three conditions: work achievement, the scientific and technological level; the working ability. These three are the major bases for evaluation. The other stipulates that experts should organize evaluation committees and the evaluation committee should evaluate personnel to judge whether the worker is up to standard or not, and the party and administrative leadership should give approval according to the experts' decisions. Of course, if it is discovered that the evaluation committee has not done things accordingly, investigation must be carried out. According to our understanding, many units have not implemented these two stipulations sufficiently well, and job evaluation has not been done according to this condition but by seniority and by the number of years of work, and people who have not worked in natural sciences have been evaluated as engineers. The masses call them "political engineers." Some units did not follow regulations in their evaluations. They are wrong and they do not seek truth from facts. They will detach themselves from the masses.

VI. The Question of Assigning Assistants to Experts

We must assign capable assistants to scientific and technical experts who have made achievements to help them better complete their scientific and technical tasks. In selecting assistants, the personal opinion of the experts must be solicited. We must guarantee that scientific and technical cadres work five sixth of the week to prevent them from taking up too many concurrent jobs. We must reduce or exempt them from administrative tasks and general social activities as much as possible. According to need and possibility, we must provide necessary books, information, instruments, facilities and working and learning conditions for scientific and technical cadres. We must actively help solve the actual difficulties in their lives. Scientific and technical

backbone members who have realized outstanding achievements must be taken care of on a priority basis.

The question of assigning assistants mainly involves finding ways for the academic skills of outstanding scientists to be passed on to the next generation. First, the expert himself can select and recommend an assistant and this assistant must inherit the expert's skills. Therefore, the assigned assistant must enable the expert to do his work well. The relationship between these two persons must be congenial. The teacher is willing to teach and the student is willing to learn.

Regarding the problem of too many concurrent jobs, the problem of a renowned scientist who is being sought here and sought there must be appropriately solved. Some experts hold administrative and leading duties, honorary duties and academic duties totaling 20 to 30 titles and all of them are "lifetime posts" without tenure. Experts feel that they are too busy and they are bothered. Experts say: "I hope you can guard against such activity because when we are asked to take up a duty, we do not feel we should refuse the offer. Meetings continue without end, there are many duties, and there is no time for academic research." The central spirit of the several opinions we have proposed is to develop advantages and avoid shortcomings, to utilize skills, and to suit measures to the person so that each can be comfortable in his own niche. Honorary positions can be reserved as the highest duties without concurrently serving lower level duties. Interdepartmental administrative and leadership positions should not be concurrently held. More academic duties should be given to middle aged backbone members, and not every position should be given to old scientists to serve concurrently. Middle aged scientists should be fully allowed to participate in academic conferences and to participate on councils and boards. Necessary conditions must be provided them in work, in learning and in living, and at least five-sixth the time must be guaranteed for them to engage in research.

VII. Training and Improvement of Scientific and Technical Cadres

We must implement the guiding principle of combining appropriate proportional distribution and suitably matched specialization, general improvement and key training. We must pay attention to the rational proportion of high level, mid level and primary level scientific and technical cadres, and the suitable matching of specialization among basic sciences, technical sciences and applied sciences. Job training of scientific and technical cadres not only includes self-learning but also many other methods. Training of youths, national minorities and scientific and technical cadres promoted from workers and farmers must be intensified and we must care about their growth. Persons who have special talents and who have scored high grades should be listed. Special training plans should be drawn up for them and they should be given better working and learning conditions for training them in a key way.

This is our policy and method to train and improve scientific and technical cadres. In general, in the guiding principle of training, we must have an appropriate proportion. Specializations must be suitably matched. We must implement general improvement and key training. Some cadres have an incorrect

understanding of continual on the job training and improvement. They believe that the school is the learning phase. The period after graduation is the working phase. Actually, the knowledge and skill of a scientific and technical cadre learned in school constitutes only 10 percent. The remaining 90 percent are learned in work and practice after graduation. Therefore, we must advocate "life-long education." Our nation has already included on-the-job training of cadres in the daily business agenda. In 1981, the general task proposed at the national workers educational work conference convened by the State Council was training for all workers. Training for all workers includes four groups: the first group is the leading cadres, the second group is managerial personnel, the third group is technical personnel and the fourth group is workers. This means, workers of each department, each enterprise unit, each agency group must be trained in general. The four aspects must be implemented: ideology must be implemented, plans must be implemented, organization must be implemented, measures must be implemented. We must not "say they are most important, but regard them as secondary in importance when implementing them, and when they are busy, abandon them." The guiding principle in work is: "Training for all, bring out the key points, uniform planning, delegation of responsibility to different levels, active development, do things according to one's capabilities, be diversified, care about concrete results." Comrade Deng Xiaoping said at the Central Committee's Working Conference: "Readjustment is an active measure that must be implemented to realize modernization. Training is an important aspect of such an active measure."

VIII. Organize Coordination and Exchange of Scientific and Technical Cadres in the Three Sectors of Scientific Research, Education and Production

The administrative departments of scientific and technical cadres at each level must organize coordination, cooperation and exchange of scientific and technical cadres in scientific research, education and production according to plan. They can also sign contracts or employ such personnel so that scientific and technical cadres can learn from each other, exchange experience, learn other's good points to make up for one's own shortcomings, and improve together.

Many units have created very good experiences by doing things this way. Many units have launched such activities among themselves and the scope of cooperation has become braoder. Departmental and regional boundaries can be broken because the development of science and technology requires comprehensive research in many aspects by various different sciences.

IX. Establish Job Performance Files

Administrative departments of scientific and technical cadres must establish job performance files on scientific and technical cadres in accordance with their scope of administration. The file includes the resume, job history, writings and academic papers, evaluation of creations, inventions and technical renovations, job evaluations, participation in foreign scientific activities, achievement in training talent, job rewards, etc., to serve as an

important reference for evaluation, for recommendation and for promotion.

This problem is a problem of much concern for scientific and technical cadres. Some scientific and technical cadres have told me: "Now, the files on cadres only list our political performance, and you do not know the level of our work and how many bowls of rice we eat." Therefore, they are very concerned about establishing a job file and this work must be done well.

The nine aspects mentioned above are some concrete guiding principles for work and major measures for managing scientific and technical cadres at present. The general goal is to fully develop the enthusiasm and creativity of the entire team of scientific and technical cadres so that the maximum effort can be exerted and greater contributions can be made to further readjust the national economy, to rapidly develop science and technology, and to hasten the realization of building the four modernizations. Efforts must be exerted so that there will be an abundance of talented people and an accumulation of achievements.

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STRATEGY FOR DEVELOPMENT OF SCIENCE, TECHNOLOGY VIEWED

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[Article by Xia Yulong [1115 4416 7893], Liu Ji [0491 0679], Feng Zhijun [7458 0037 3182], and Zhang Nianchun [1728 1819 2797]: "We Should Praise the Type of 'Priceless Treasure' of 'Goldbach's Conjecture'; We Should Pay More Attention to Technology--the 'Valuable Treasure'--for Creating Economic Values for Society; Discussing the Strategy for the Development of Science and Technology"]

[Excerpts] "Science and technology are parts of the productive forces" and "the modernization of science and technology is the key to the realization of the four modernizations." These glorious theses of the party Central Committee are now known to everyone. However, how do science and technology serve the national economy and how do they effectively demonstrate their productive forces? This question is now prominent on our daily discussion agenda. If this question is not properly answered, it not only will seriously affect the progress of our country's modernization but also will directly affect the future of science and technology themselves. We believe that in order to solve this problem it is necessary to understand more clearly the policy established by the party Central Committee and State Council for coordination between science and technology development and economic and social development. The development of the national economy should be the primary task of science and technology. A strategy for the development of science and technology that reflects this policy should be established, consistent with our national conditions and the laws of science and technology development, so that it will direct our country's science and technology work now and in the future.

Differentiate Between the Functions and Effects of Science and Technology

The words "science and technology" are now widely used as a single term. In actuality, they embody two concepts of different meanings. In the Latin dictionary, science has the meaning of "knowledge" and "understanding." Scientific research is a social movement exploring the essence and laws of nature. It generally covers the six major sciences of mathematics, physics, chemistry, astronomy, earth sciences, and biology. The original meaning of technology is "proficiency." Proficiency produces skill and skill is technology. The solving of problems of widespread significance in production and labor, from technical invention, research in product manufacturing, to the promotion of application, is all part of technological research. Following the

development of modern science and technology, the relation of the two is closer and closer. The so-called "technologicalization of science" and "scienceization of technology" are being accepted more and more. However, they do have different functions and effects. Generally speaking, these differences are in the following areas: first, they have different forms. Science is expressed primarily in the form of knowledge. Technology always is in a definite material form. Second, the objectives are different. The primary objective of science is to understand the world. It primarily answers the questions of "what" and "why." The objective of technology is to reconstruct the world. It primarily solves the problems of "what to do" and "how to do it." Third, the methods of topic selection are different. Science is mainly reflected in free exploration. On the other hand, technology generally always has a clearly defined practical target. Fourth, the time frame of research is different. In scientific tasks, a completion date should not be insisted upon. But there is generally a concrete time frame for all technological research. Fifth, the economic benefits are different. The economic benefits of scientific research are not specifically determined and are long-range. Direct and specific economic benefits can always be achieved in technological research. Despite the close connection of science and technology, a definite or an inevitable relationship does not exist between them because of these differences. That a country is well developed in science does not mean that it is also ahead in technology. The opposite could also be true.

Only by differentiating between "science" and "technology" can we handle correctly their internal relationships and external connections and achieve the coordinated development between science and technology and between science and technology and economy and society. This is the basic prerequisite for the establishment of a strategy for the development of science and technology.

Consequently, for science, we cannot put into practice a policy of urgent success and quick benefits. We cannot strictly demand short-term economic benefits and values in commercial products. The experience of scientific research has shown that the results of its practical application can only be achieved after many years. From this, we can therefore see that if our country wants to achieve modernization by the end of this century we cannot put our trust in science alone. We must pay important attention to the research and development of technology. The vigorous development of research in new skills, new products, new technology, and new processes in the fastest way to shorten the period of time for reaching the advanced world levels.

To put it succinctly, our strategy for science and technology must begin with the total requirement of realizing the four modernizations. We must differentiate the functions and effects between science and technology, thereby correctly establishing short-term, mid-term and long-term objectives and policies and carrying out fruitful research in order for them to make a contribution in expediting the development of our national economy.

We Must Start With National Conditions

The current conditions demonstrate that our country is backward in science, backward in technology, and also backward in equipment. They all need urgent development, requiring investments in manpower, funds, and materials. However, China's economy is also backward. Funds are not adequate, materials are limited, and qualified personnel are also in short supply. They cannot satisfy the requirements for various investments. This is a contradiction. On the one hand, to change our economic backwardness as rapidly as possible also depends on science and technology. Thus, a cycle of contradiction has been created. The key problem is how to use our limited personnel, funds, and materials to the best advantage and develop the pitting one against ten." Obviously, we cannot immediately stand side by side in modernized science and technology with advanced countries. However, exactly how they have relied on science and technology for their modernization, and their experiences and lessons are worth our conscientious study.

England was the earliest country to become modernized. It is the birthplace of the Industrial Revolution. Relying on steam engine energy and other technology, it was at one time a large industrial nation with great influence. However, it has declined since the turn of the century. In the 1950's it was barely able to remain the second strongest nation in the capitalist world. By the 1960's it had fallen rapidly to the fifth position. By 1980 its position was second to last among the seven European countries in terms of per capita national production. Is this because England's level in science is too low? No. England has traditionally paid important attention to science since the 16th century and great names in science have appeared generation after generation. Even today, when computed on the population average, it is still the country with the largest number of Nobel Prize winners. What then is the cause for its decline? The reasons are many. However, a misguided policy in science and technology must be mentioned as one of the important reasons. Many scholars abroad have pointed out: "Although England's basic science is still advanced, their application of technology is poor." This statement is quite reasonable. In recent years, the science and technology sector of England has begun to reexamine itself. In 1979 the Commission for the Advancement of Science of England called a conference specially to discuss the problem of coordinated development of science and technology. The goal of the conference was clearly spelled out across the chairman's platform: Technology--Our Future.

Science and technology in the United States were born during the War of Independence. They grew in strength during the Civil War and matured during World War II. They have achieved full development since the 1950's. The United States has always been well known as a land of practical people. It devoted its entire energy in the early days to technological research and application and it is exactly through the reliance on its strength in technology that it has maintained its position as the world's economic giant ever since 1980. However, the United States did not achieve its leading position in science until after World War II. During the war, famous scientists from Europe and all over the world went to the United States. Also the highly developed military technology has urgently demanded the development of new

avenues through scientific research. The then head of the Bureau of Scientific Research, presented his famous report to the President, advocating the increase of investment in scientific research. The "artificial satellite effect" of the Soviet Union in 1957 particularly gave the United States a very strong stimulus. During 1958-60 the budget for the National Science Foundation suddenly increased by more than three times. From then on, science in the United States progressed and developed and the number of Nobel Prize winners jumped to the leading position in the world.

After World War II, the Japanese economy collapsed completely. And now after only a few years, it is economically the second largest country in the capitalist world. Japan's level in science is not high. The number of Nobel Prize winners can be counted on one's fingers. What strength did Japan depend on to push its economic recovery? Not long ago, the report of a study by the British Government pointed out that Japan treated "the concerted use of technological development by the entire country as the absolute road to economic recovery." Using the words of the Japanese themselves, they chose "national construction through technology" as their strategy for development. Simultaneously, with the steady development of basic research, they paid particular attention to applied technology to improve their competitive market power and to improvements in technology for product quality, technology in productive skills, and synthesis technology. They not only imported advanced technology from abroad but also vigorously developed their own technological research. Through analysis and synthesis, they created first rate products in the international markets and the country achieved modernization within the short period of 20 years.

In summary, we can reach two conclusions that could be used for reference:

1. Although the conditions in the countries were different, in their early stages of modernization they all followed the road of emphasizing the development of technological research and relied on the development and application of technology rapidly to upgrade their national economy.

2. Basic scientific research should be strengthened after the economic strength and technological foundation have reached a certain level. By that time, coordinated development in rational proportions should be maintained for science and technology. However, even then, the superiority of technology cannot be neglected.

Place Selective Emphasis on Research of Applied Technology

Without selective emphasis, there is no policy. In studying our country's development in science and technology, what are the foreseeable emphases? This is the key in establishing a strategy for the development of science and technology. We believe:

1. Basic research should be done, but emphasis should be placed in the research of applied technology and in the development and application of technology. Basic research should be maintained at a steady ratio and gradually increased as the economy develops.

2. Sophisticated research should be done, but emphasis should be placed on the development and application of productive technology. Technological development and research for product development should be used to promote economic development, especially in technology that is closely related to the clothing, food, lodging, and travel of the people. They should be used to promote the development of agricultural productive forces and diversified economy and to promote the technical reconstruction and the technological innovation of existing enterprises.

3. Creative research should be done, but emphasis should be placed on absorbing the technologies which are already established abroad and which are suitable to the practical needs of our country and adopting them to our needs through technological research, digestion, synthesis, and creativity.

The above three points may be summarized in one sentence: emphasis should be placed in the research of applied technology. This is the strategy that we need for the development of science and technology.

Of course, all scientific research cannot be treated in the same manner. Many subjects which are closely related to technological development should be given greater attention, such as applied mathematics, surface physics, etc. All technological research cannot be treated in the same manner either. The "technology secrets" that cannot be imported from abroad should become the emphasis for research.

If this development strategy is correct, aside from adopting appropriate measures in investment, the policy must still receive systematic implementation, changing current conditions which are not entirely rational.

1. In the work of propaganda, attention should be given to the coordination of relationships between science and technology. In the work of publicizing the role of science and technology, very good results have been achieved in recent years. However, greater publicity has been given to basic sciences, especially pure mathematics, theoretical physics, etc. This has created a wrong impression, that the economy will prosper and the four modernizations will be realized with progress in these sciences alone. Many superior youths are taking mathematics and physics as the objective of their struggle. (For instance, in the Physics Department of the Fudan University alone, there are over 1,100 students, representing 1/5 of the school's total enrollment.) On the other hand, superior students are not easily recruited for such specializations, which are urgently needed for the establishment of the four modernizations, as agriculture, geology, chemical engineering, hydraulics, management, economics, and law. This situation is irrational.

2. In the area of social position and remuneration, attention should be given to the improvement for personnel engaged in applied technology work. The social position and remuneration of our country's scientists and engineering and technical personnel have had some improvements in recent years. However, in contrast, the position of engineering and technical personnel is not consistent with their role for the four modernizations.

3. In the area of evaluation and promotion, there should be some differentiated treatment. It is very good to note that among the scientific personnel in our country a group of researchers, assistant researchers, professors, and assistant professors have been promoted in recent years. However, the number of engineering and technical personnel promoted to senior engineers has not been large. We believe that in the evaluation and promotion of engineering and technical personnel the quality of their papers and their foreign language abilities should not be the only criteria. Their ability to solve practical problems and their contribution to the creation of economic values should be the primary standards.

In summary, we should praise the type of "priceless treasure" of "Goldbach's conjecture." At the same time, we should double our emphasis on the "valuable treasure" which creates economic values for society--technology. By this walking with two legs, science and technology will be able to push forward economic development on an even better basis. And science and technology will also achieve their own splendid future in economic development.

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QIAN XUESEN: ALL SCIENCE EVENTUALLY CONVERGES ON MARXIST PHILOSOPHY

Beijing ZHEXUE YANJIU [PHILOSOPHICAL RESEARCH] in Chinese No 3, Mar 82 pp 19-22

[Article by Qian Xuesen [6929 1331 2773]: "The Structure of Modern Science--a Rediscussion of the Study of the Scientific and Technological System"]

[Text] In my previous discussion of the systematic structure of modern science and technology (see footnotes 1, 2, 3 and 4), I felt that, from application to basic theory, modern science and technology may be divided into four levels: first, the level of engineering technology; then, the the level of technological science serving directly as the theoretical basis of engineering technology; thereafter, the level of basic science; finally, by means of further synthesis and purification, the Marxist philosophy, the supreme epitome. The division may also be regarded as four steps, or a horizontal division, from the practical technology to remold the objective world to the supreme philosophical theory. The vertical division is the classification of academic subjects into categories. According to the general view, the large categories are natural science and social science. China now has the Chinese Academy of Sciences and the Chinese Academy of Social Sciences and their branches in the various provinces, municipalities and autonomous regions, the two systems. Nevertheless, I feel that, if we consider the present situation and future development of science and technology, the large vertical categories should be natural science, social science, mathematics, systematic science, cogitative science and the science of the human body, a total of six. How do we regard these six categories? What are their dividing lines? Generally speaking, they are all parts of the knowledge of the laws of the objective world gained through practice. The traditional view is that the categories of science are divided according to the realms of their objectives, with nature the objective of natural science and the human society the objective of social science. However, there is a flaw in such division: As mathematics is a natural science, it is seldom applied in social science. This defect has been recognized by many people.[5] It leads me to reexplore the issue of the structure of modern

science and technology: How are the six large categories divided? Do we divide them according to the realms of their objectives? Or is there another way?

This article expresses some views on the issue for discussion, criticism and correction by my comrades.

I. Though the range of study of natural science was the world of nature in the 16th and 17th centuries, actually, after the 18th century Industrial Revolution, it was no longer limited to nature. Physics, chemistry, biology, astronomy, geoscience and other numerous technological sciences and engineering technologies in today's natural science involve the entire objective world, both natural and man-made. Of course, natural science has its characteristic, which is the focus or angle from which it views the objective world. It is the central idea of natural dialectics advanced by Engels approximately a century ago: the study of the motion of matter in time and space, the different levels of the motion of matter, and the interrelations of the motion of matter at the different levels. To summarize it again, natural science observes the entire objective world from the focus, or the angle, of the motion of matter. When a natural scientist looks at a machine manufacturing plant, he does not focus on its finances, operation and management, and economic conditions, but regards it as a place of material flow and of processing and cutting, and studies its energy consumption, the wear and tear of its machinery, and the quality and function of its products.

As the focus of natural science is the motion of matter, its study cannot be separated from quality, length and time, the three quantities, known as the basic dimensions. Other quantities emerging in the large category of natural science are all formed by the three basic dimensions. The application of this crucial fact results in an extremely important method of study in natural science, known as "dimensional analysis," and it often enables us to see clearly the mechanism of matters. For instance, the constant, quality and light velocity, the three quantities of gravitation, cannot form a numerical value without dimensional analysis, because length is missing, and length is the radius of the so-called "black hole" of a given quality. Nevertheless, unrelated to the three basic dimensions of natural science, the quantities of social science have nothing to do with length, quality and time, or their combinations. Therefore, from the angle, or the focus, of the motion of matters, we can distinguish natural science from other large categories. For the same reason, we should consider natural dialectics the bridge from natural science to the Marxist philosophy.

What is the characteristic of social science? From what focus, what angle, does social science study issues? As I suggested previously,[2] the bridge from social science to the Marxist philosophy is historical materialism. Thus, it reveals to us that the focus, or angle, of study of the objective world in social science is the development motion of the

human society, the internal motion of society, and also the influence of the objective world on the development motion of the human society, such as environment, ecology, energy, resources, etc. People may say that, if so, one cannot claim that social science takes the entire objective world as the objective of study, as the human society only exists on earth! However, let us take a look backward. Only a few hundred years ago we were unaware of the existence of earth, and thought that society only existed on a small square piece of land with the sky as the dome! Yet now we have learned that the motion of the sun influences our economy, because it affects the climate and wireless communication on earth. As for the future, the social activities of mankind will, by means of the technologies of spaceflights and flights in the universe, expand to the entire solar system and beyond. How can we say that social science does not study the entire objective world?

Therefore, we may say that social science studies the entire objective world from the focus or angle of the development motion of the human society, and that the bridge from social science to the Marxist philosophy is historical materialism.

II. Regardless of which branch, modern science and technology cannot be separated from mathematics, from one or more subjects of mathematical science. Therefore, that mathematical science is the study of the entire objective world is easily understood. What we want to discuss is the focus or angle from which it studies the objective world. Comrade Hu Shihua [5170 0013 5478] has written an article on this issue.[6] He says that the philosophical basis of mathematics is the opposite unity of quality and quantity and their mutual transformation. I agree with this view. The remaining work is to intensify this concept from the methodology and historical development of mathematical science and enrich its substance, making it into a field of learning, a bridge to the Marxist philosophy. Comrade Hu Shihua has done some work,[7] but he says that he will pursue it further. Comrade Ouyang Jiang [2962/7122 4829] has also brought the issue up,[8] and calls it the science of mathematics. Thus, the views of everyone have been centralized, and the work of building a bridge from mathematical science to the Marxist philosophy should be started.

III. I have already discussed systematic science in my previous article.[3] The characteristic of systematic science is the systematic view, or, one may say that it is to regard the entire objective world from the systematic focus or angle. Therefore, the issues handled in systematic science include issues of nature, such as the sequential phenomenon in biology and social issues, such as the economic system, the legal system, etc.[9] As they are unified in the systematic view, if it is said that the systematic theory is the bridge from systematic science to the Marxist philosophy, then the systematic view is a component of Marxism.

Cogitative science, since its proposal, has aroused the interest of many comrades. As the basic work in this aspect is still very inadequate and

only the study of logical thinking is fairly thorough, unanimity in understanding is still difficult to reach. Man's thinking under conscious control is classified into logical, imaginal and inspirational, its three forms, divided according to the different inherent laws of thinking. Some comrades seem to confuse them with the various different components in the thinking process and propose emotional thinking as a sort of artistic thinking.[10] If so, then we can also propose "writing thinking," "scientific research thinking," "creative thinking,".... Such classifications are actually the process of the application of the three cogitative activities in a certain aspect, including one or more of them in each process. Therefore, emotional thinking is not a basis of cogitative science, but its application, and should not be juxtaposed with logical, imaginal and inspirational thinking. Another problem is the confusion in the terminology of the three basic cogitative activities: Logical thinking is also known as abstract thinking, while imaginal thinking seems to be familiar to comrades in literary and artistic work, but not in the field of science. Scientists are accustomed to use the term heuristic or physical as a distinction from logical and mathematical. Comrade Zhang Guangjian [1728 0342 7002] proposed the term "similarity thinking."[11] Actually, according to my own experience, these terms all indicate imaginal thinking. As for inspirational thinking, the characteristic is its suddenness, and it may be described in the Buddhist term of "sudden enlightenment." For the convenience of discussion, we may call the three kinds of basic thinking abstract (logical) thinking, imaginal (heuristic) thinking and inspirational (sudden enlightenment) thinking.

How can we say that cogitative science studies the entire objective world? Because the goal of cogitative science (see footnotes 3 and 4) is to understand how man interprets the objective world and how he stores and processes in his brain the perceptual information gained in practice and turns it into his interpretation of the objective world. It is also for this reason that thinking is linked with the entire objective world, and that epistemology is the bridge from cogitative science to the Marxist philosophy. Naturally, with the development of cogitative science, the epistemology discussed here will also greatly develop and intensify, no longer limited to the classic epistemology. Classic epistemology has not epitomized the detailed knowledge of man's cerebral activities; therefore, it does not have the foundation of the new cogitative science which will develop, but remains in the stage of cogitative discrimination, with fairly great limitations. Though the accuracy of quantum mechanics, for instance, had been verified in experiments, by starting from classic epistemology in the past five decades or more, controversies were touched off,[12] which have remained unsolved till today, leading to the peculiar "many-worlds theory" of H. Everett, B. S. Dewitt and N. Graham.[13] It appears that the issue can only be solved alongside the study of cogitative science and the new development of epistemology.

The science of the human body is a branch of the ancient yet novel science and technology.[4] Ancient because many of its subjects, with an extremely rich substance, have long been established, and our understanding of the

entire science of the human body has its source in China's ancient tradition, such as Chinese medical theories and the system of deep breathing. The currently controversial unique functions of the human body have only gained serious attention in China in recent years. On the other hand, the science of the human body is very novel. By bringing to light China's ancient tradition, it is given a new direction. In other words, man is considered an entirety, to be placed in the whole universe for study and to be linked with the universe. It is the new concept of man and nature. The climate, the sun, the moon and the entire universe influence man, while the human body will also influence the external world. Therefore, the science of the human body is to observe the entire objective world via the focus or angle of the human body. Not only the various components of the human body cannot be observed separately, but the human body and the external world cannot be considered separately. The concept of man and nature will also become a component of the Marxist philosophy, while the "theory of man and nature," synthesized and purified through the further development of the science of the human body, will be the bridge from the science of the human body to the Marxist philosophy.

The foregoing is my view on the structure of modern science. Natural, social, mathematical, systematic and cogitative sciences and the science of the human body, the six large categories, each interpret the entire objective world, except that each observes the world from its own focus or angle, natural science from the motion of matters, social science from the development motion of the human society, mathematical science from the opposite unity of quantity and quality and their mutual transformation, systematic science from the systematic concept, cogitative science from epistemology, and the science of the human body from the concept of man and nature. Observing from different focuses or angles, each finally builds its own bridge and all converge on the Marxist philosophy--the supreme epitome of man's understanding. Therefore, only the Marxist philosophy is the scientific philosophy; naturally it must guide scientific and technological research. Thus, modern science forms into an inseparable and solid unified system, the system of modern science and technology. The further study of this system is the task of the scientific and technological system.

Is this view right? Should we not explore it further?

January 1982

FOOTNOTES

1. Qian Xuesen, "the Study of Science, the Study of the Scientific and Technological System, and the Marxist Philosophy," ZHEXUE YANJIU, No 1, 1979 pp 20-27

2. Qian Xuesen, "on Establishing and Developing the Study of the Marxist Science," KEYAN GUANLI [SCIENTIFIC RESEARCH MANAGEMENT], No 1, 1980 pp 1-6

3. Qian Xuesen, "Natural Dialectics, Cogitative Science and the Potential of Man," ZHEXUE YANJIU, No 4, 1980 pp 7-13

4. Qian Xuesen, "Systematic Science, Cogitative Science and the Science of the Human Body," ZIRAN ZASHI [NATURE MAGAZINE], No 1, 1981 pp 3-7

5. Liu Wen [0491 2429], "Social Science Must Also Modernize," GUANGMING RIBAO, 8 Dec 81 p 3

6. Hu Shihua, "the Opposite Unity of Quality and Quantity in Mathematics," ZHEXUE YANJIU, No 1, 1979 pp 55-64

7. Hu Shihua's talk

8. Ouyang Jiang, "Preliminary Exploration of the Science of Mathematics," academic paper at the first annual meeting of the China Natural Dialectics Society, 1981

9. Qian Xuesen, "Vigorously Develop Systematic Engineering; Establish Systematic Science as Soon as Possible," GUANGMING RIBAO, 10 Nov 79 p 2; also in "Collection of Academic Papers on Systematic Engineering," Science Publishing House, 1981 pp 1-7

10. Huang Zhizheng [7806 3112 2973] and Yang Anlun [2799 1344 0178], "on Emotional Thinking--a Conception of Man's Thinking, Especially Artistic Thinking," QIUSUO [SEARCH], No 3, 1981; also in XINHUA WENZHAI [XINHUA DIGEST], No 10, 1981 pp 167-171

11. Zhang Guangjian, "a Discussion of the Study of Similarity," QIAN KEXUE [LATENT SCIENCE], No 3, 1981 p 39

12. F. Jammer, "the Philosophy of Quantum Mechanics," John Wiley and Sons, 1974

13. B. S. Dewitt and N. Graham, "the Many-Worlds Interpretation of Quantum Mechanics," Princeton University Press, 1973

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MARXISM HELD CRUCIAL TO DEVELOPMENT OF 'SCIENCE OF LEADERSHIP'

Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese, No 1, Jan 82 pp 38-40

[Article by Li Ruiying [2621 3843 5391] And Shi Yanjiu [4258 8827 3773] of the Theoretical Department of GUANGMING RIBAO, edited and released by Ren Zhenjiang [0117 2182 3068]: "The Research Subjects of Science Led by Marxism"]

[Text] The proletariat acquired its own complete system of thought and revolutionary theory only after the birth of Marxism. Under the guidance of this great theory, the proletarian revolution and construction were gloriously carried out. If we say that an important characteristic of Marxism is its pragmatism, then, it is only possible to truly, fully and systematically practice Marxist theory under conditions of socialism. This is because the social practices following the success of the proletariat revolution and the social practices prior to the revolution are very different in content, form, depth and broadness, for example, the practice of political leadership to strengthen proletariat dictatorship and consolidate the socialist system, the practice of administrative leadership to readjust socialist production relations, the practice of vocational leadership to manage the socialist economy and science and technology. All of these practices and activities have trained the proletariat revolutionary, enabling him to accumulate a massive amount of precious work experience, and on the basis of these experiences, enabling him to create outstanding working methods and the art of leadership. The number of pages of writings on Marxism dedicated to the working method and the art of leadership, has increased. This is an attractive characteristic in the history of development of Marxism.

Therefore, the concrete application of the basic theory of Marxism in leadership work may possibly be the emergence of a brand-new applied theory out of the system of Marxist theories--the science of leadership.

The Marxist science of leadership can become a discipline because it has its own specific research subjects which are the general structure, model, process and laws of motion of leadership. Discussing the research subjects of the science of leadership has a definite practical and theoretical meaning in establishing a scientific leadership theory and in improving the level of work of leading cadres.

(I) The Research Subjects of the Science of Leadership

1. The Question of the Social Structure of Ordinary Leadership

The science of leadership, as a science of modern social management, is actually the discipline of understanding, adjusting and controlling the basic conflicts of society. The common term "social management" is the management of society's productive forces, production relations and superstructures via definite means. What we call leadership also refers to leadership in the various social sectors mentioned above, such as political leadership, administrative leadership and vocational leadership (including economic, academic and military leadership, etc.). Political leadership is mainly the management of the superstructure. Administrative leadership is mainly the management of personnel, logistical support, and public service policies which involve production relations (such as wage relations). Vocational leadership is basically the management of productive forces with the exception of a few superstructure sectors. Therefore, the science of leadership naturally forms three main branches in these three sectors: (1) the science of political leadership; (2) the science of administrative leadership; and (3) the science of vocational leadership.

Lenin once pointed out: "Politics is a science, an art; it does not fall out of the sky. It is not something we receive gratis." ("Selected Works of Lenin," Vol 4 p 247.) This means, the science of political leadership is not a record of the revolutionary enthusiasm of leaders or the manifestation of personal wills. It is a scientific theory that is consistent with the objective laws of political leadership.

For example, the question of the social status of social and political leadership under socialism is an important subject in the science of political leadership. Because conditions at the time when the nations began establishing socialism were different, the concrete form of transition from capitalism to communism necessarily was and should be varied. The characteristics of the nationalities were different, and there were regional differences, different characteristics of economic structure, different life styles and differences in ideological awareness of the people. Therefore, the concrete form of transition to communism in each country was different. This greatly influenced the general structure of leadership in society. Generally speaking, socialist nations frequently have as a leadership structure, a triumvirate leadership structure of "politics--administration--vocation" guided mainly by political leadership.

But it must be pointed out that emphasizing the main guiding function of political leadership does not in any way negate the basic function of vocational leadership. Marxism has always held that every socialist nation should regard the development of social productive forces as its own important historical task. The development of productive forces can never be separated from vocational leadership. At the same time, the nature of the socialist society determines that its economy is mainly planned and its management is mainly centralized. Therefore, a socialist nation relative to any nation of a different social system will abstain more from the antiscientific "vocational

"leadership," and it will abstain more from the "blind command" of subjectivism, because this type of antiscientific "vocational leadership" brings more severe losses to centrally managed nations than to nations under decentralized management. Many historical experiences and lessons have proven this point. It would be very dangerous not to advocate vocational leadership, or shall we say, if the political leadership does not take vocational leadership as the foundation, it would be very dangerous. Just as in the course of war, defeat is inevitable if the political leadership does not take military leadership as the foundation.

Administrative leadership is the intermediate link between political leadership and vocational leadership. Without administrative leadership, political leadership will not be able to develop an active function in vocational leadership. Like the superstructure, when it is separated from the medium of relations of production, it will not be able to develop its function as a productive force. The political and ideological work of the leaders can stimulate the enthusiasm of the workers, but this cannot be sustained for a long time. Political leadership also must rely on the medium of production relations, utilize appropriate adjustments in the ownership of productive information and utilize continued reformation of the relations in the distribution of the products of labor and various types of social relations to guarantee the conditions for reproduction by the labor forces, to stimulate and further heighten the enthusiasm of the laborers. In one statement, we must rely on administrative leadership which includes personnel, logistics and service departments to create definite social conditions for vocational leadership and to set up a firm bridge for political leadership to lead to vocational leadership.

The concrete structural forms of the three forms of leadership, political leadership, administrative leadership and vocational leadership vary with the different situation in each nation and with the degree of development of productive forces. But, political leadership (especially the central function of the proletariat political party) cannot be weakened. The task of the science of leadership here is to study the mutual relationship of the various types of leadership under different social conditions and to study the social structure and measures of social control necessary to realize this type of leadership structure.

2. The General Model of Leadership and Its Laws

In a class society, the process of leadership (especially political leadership) frequently has a strong class character. But, from the viewpoint of organizational effects, the question of the general structure and the model of leadership is a technical problem that does not have any class character. According to this viewpoint, the so-called "leadership" is a process and an action. Concretely speaking, it is a process of a special type of mutual action between individuals (the leaders or leading group) and the groups of people (political party, class and masses). It is also a self-conscious action that influences people to achieve a certain group goal. Such actions are all common actions that are led. Here, the individual emerges from the masses and he can control and influence the action of the group. The group is a social group

directed and influenced by individuals using different methods. Regardless of how different the methods of mutual action between the individual and the group, creating the greatest organizational effect and striving for the best social result are the consistent goals of leadership.

Because the methods of mutual action between the individual and the group are different, the general model of leadership is generally divided into the following types: (1) collective leadership and leadership at different levels; (2) individual responsibility and individual leadership; (3) direct interference and direct solution (Refer to "Selected Works of Zhou Enlai," Vol I, p 129). This means, the method of mutual action between the individual and the group in the process of leadership are of three types: "strata," "linear" and "tunnel" types. These three types are suitable for use in different situations. They are mutually independent but they are also mutually complimentary.

3. The General Process of leadership and Its Laws of Motion

If we say that leadership is the process of special mutual action between the individual and the group, then the information carrier to realize such mutual action is mainly policy. According to the different functions of formulating policy, centralization, decisionmaking, execution, and feedback, the process of leadership can be generally divided into five stages: (1) investigate and research stage; (2) formation of policy stage; (3) policy decision making stage; (4) policy execution stage; (5) examination and revision stage.

Investigation and research are the basic working methods in Marxism. They are also our starting point in establishing any policy. Because of the randomness of social phenomena and the uncertainty of social understanding, frequently, social surveys become very difficult and complicated. To discover problems and solve problems, people have divided investigation and research into two stages. The first stage is to carry out typical surveys to discover problems, i.e., "one-time survey and research." The second stage is to carry out systematic investigation to solve problems, i.e., "second investigation and research." Whether in "one-time survey" or in "second surveys," both should utilize the method of comprehensive analysis in systems theory to perform statistical analysis of the facts obtained. We must utilize fully the special functions of typical information, and we must also eliminate the limitations of typical information and exert efforts to extract statistical probabilities from typical information that have policy value. Therefore, investigation and research constitute a very complex discipline. The exploration of the laws of investigation and research by Marxism may produce a scientific theory for the science of investigation and research.

The conclusion of the stage of investigation and research signifies the beginning of the stage of policy formation. Because of the different positions and viewpoints of the investigators, and because of the different methods of processing investigative information, the conclusions are thus varied. The policy plans carried out to solve social problems will also be varied. What we call "policy formation" is gradually reached through mutual debate and the process of elimination. Debate frequently produces several coexisting plans in

a "multiple state" of policy plans. The "multiple state" of policy is an important characteristic of the stage of policy formation. It is also the necessary condition that the policy stage arrives. Without many plans, the question of the so-called "best selection" will not exist.

After debating and screening policies, the different policy plans submitted to the leaders should be said to be plans that will withstand scrutiny. In the view of planners, the plans coincide with at least the objective situation at the time of investigation. But, will they suit the overall situation, or shall we say, what effects will the plans have on the overall situation? The highest leaders who have the overall situation in their grasp must make the decision. For example, during the period of war, the leaders can sacrifice certain parts of scientific nature of the policy to satisfy the needs of political struggle or military struggle. These situations are all for winning the greatest success in work and the final victory in combat.

Promulgation of a policy is easy, but, whether this policy is executed correctly is fairly difficult. To correctly implement this policy, a lot of detailed work has to be done. Because policy is the reflection of the general laws of things, it cannot suit the actual situation of every locality. Therefore, we must first carry it out at "test points" and then carry it out on an overall basis. The so-called "theory of policy execution" is to study the method of combining the general and the specific and improve the maximum results of policy execution.

In the stage of policy execution, problems and shortcomings will necessarily emerge. To solve this problem, the leadership agencies must send people to the masses to inspect the execution of policy and to gather feedback on the policy, either to correct any deviation in the execution of the policy or to supplement and perfect already established policy. In this way, the feedback on the policy will return the leadership process to a higher level of investigation and research, and a new leadership process thus begins.

In general, the Marxist science of leadership should study the special laws of concrete leadership processes and establish the Marxist theory of investigation and research, the theory of policy formation, the theory of policy decisionmaking, the theory of policy execution and the theory of policy feedback. Expressed in one sentence, we want to establish the Marxist science of leadership.

(II) Alliance of the Science of Leadership and the Techniques of Leadership

We must emphatically point out that the study of the Marxist science of leadership does not signify a negation of the Marxist techniques of leadership. The techniques of leadership and the science of leadership are inseparable and they are two mutually complimentary sides. When we say that the techniques of leadership await being elevated to a science of leadership, we mean elevating the skills of leadership established on the foundation of traditional social science which can only be described by qualitative methods to a science of leadership which awaits being elevated under Marxist guidance and which is

established on a modern scientific and technological foundation that can combine quantitative analysis and qualitative analysis.

Perhaps some will think that when there is such a science of leadership, the leaders will not have to exert any mental effort. They can utilize the computer and sit back and enjoy the fruits of labor. Actually, this is a misconception. The science of leadership will never at any time and will not possibly become a "miracle drug" that will cure all ills. The science of leadership only exposes the laws of social leadership to let the leaders realize social policies by following scientific laws. Whether the policies will be of high standards or low standards still depends on the development of the leadership techniques of individual leaders. Therefore, social policy will not be separated from the techniques of leadership at any time. The greatest advantage of the techniques of leadership is its dynamism and creativity. It can utilize decisionmaking methods in a versatile manner according to the actual situation. Yet it is precisely because of this that the techniques of leadership also manifest one's greatest weakness, i.e., the so-called "abnormality." The same leadership technique used by different people will produce vastly different results. For example, disecting the sparrow (analyzing a microcosmos), learning at the locality, running about and such investigative techniques have been used by some people to make Marxist decisions while others have become advocators of subjectivism "armed with facts." Because the simple techniques of leadership are largely dependent upon individual talent, intelligence, aura, style of work of the leaders, therefore, in a certain region or at a certain unit, the normal transfer and replacement of leaders will frequently cause a change or interruption in the execution of policy and loss in work which should not have occurred. Thus it can be seen that it is not only a historical necessity for abnormal techniques of leadership to be elevated to become a normalized science of leadership, but at the same time, it is needed in building socialist modernization. We believe that further development of the science of leadership may produce higher level techniques of leadership which will include a fixed model of "software techniques" of leadership. The development from leadership techniques to a science of leadership and then from the science of leadership to techniques of leadership is an unlimited, repetitive and spiralling process of understanding. It is also a method of historical dialectics between the techniques of leadership and the science of leadership. All methods that separate Marxist techniques of leadership from the Marxist science of leadership are wrong.

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ACADEMY OF SCIENCES ROLE IN SCIENTIFIC RESEARCH REVIEWED

Beijing ZIRAN BIANZHENGFA TONGXUN [JOURNAL OF DIALECTICS OF NATURE] Vol 3 No 3, 10 Jun 81 pp 25-30

[Article by Luo Wei [5012 0251] of the Policy Studies Office of the Chinese Academy of Sciences: "The Position and Role of Academy of Sciences in Chinese Scientific Research System"]

[Text] In 31 years of development history, the Chinese scientific research system has formed five branches: The Academy of Sciences, schools for higher education, industrial research organizations, local research organizations and defense research organizations. (In this article we shall only discuss natural sciences.) The Academy of Sciences is the highest academic organization and general research center in China; it mostly engages in the research of basic sciences and some technological sciences.

In the discussion of improvement of the system, many comrades have expressed their views on the merits and shortcomings of the present Chinese research system. One important aspect of the system is the status and role of the Academy of Sciences. Many comrades believe that the Academy of Sciences should be strengthened and constantly improved so as to play its full role as the highest academic organization, and take full advantage of its interdisciplinary nature in solving general and pivotal scientific and technological problems in China's national construction and make more contributions to China's modernization. There are also some comrades who believe that basic scientific research should be concentrated in institutes for higher learning, technological science research should be closely related to production departments and should therefore be combined into industrial research organizations so the Academy of Sciences would no longer be a research entity but an honorary and consulting organization. We wish to express some opinions regarding this question.

Scientific Research Is Gradually Becoming an Enterprise of National Scale

We first look at the historical development. Along with the growth of modern science, the principle form of organization in natural science research in the world, although different from country to country, has largely followed the progression from individual research activity, to college and university laboratories, to industrial research organizations, to national research

organizations and finally international research organizations. Furthermore, governments in various countries have also increased their intervention on the science enterprise in terms of organization, planning and expenditure.

Science has exhibited some of its characteristics in the process of development. First, it is increasingly society-oriented, it is becoming less and less likely to be conducted by one or a few individuals. Experimental research such as that conducted by Madame Curie is no longer playing a leading role.) Second, experimental methods are becoming increasingly sophisticated, extensive and complex. They are no longer within the financial reach of a few individuals or a single enterprise. Third, science and technology are moving in the direction of integration and breakthroughs often appear between disciplines and, in the meantime, many problems in science and technology are no longer solvable by knowledge in only one field. These characteristics dictate that scientific research gradually move toward a national scale. Although each country has a different mode, there are still some common features: (1) Government allocation makes up a relatively large fraction of the total national scientific research expenditure; 57 percent in the United States, 54.6 percent in Great Britain; 47.7 percent in West Germany, 42.6 percent in Japan and 55.8 percent in France (all 1975 statistics). (2) Basic research and major scientific and engineering projects are mostly supported by the state. (3) The state is increasing its guidance, coordination, support and funding for scientific research development. (4) Major research projects are often concentrated in national research centers and research organizations in various branches of the government.

In China, the research organizations of various industrial departments (including central and local governments and defense departments) are mostly engaged in development work closely related to the production assignments of the department or the region and some associated applied research. Long-term, fundamental, exploratory and theoretical research which cannot be applied to production now but are required by production development in the future and interdepartmental, interprofessional and interregional research which require the cooperation of many disciplines will have to be conducted by the state or by state-funded research centers. At present, this part of research in China is essentially placed in the Academy of Sciences and it also seems to be consistent with the international trend of science development.

Study Other's Experience and Choose Our Own Direction

An overview of the different research systems of major countries in the world shows two types of systems. In one system there are concentrated national research centers such as the Academy of Sciences in the Soviet Union and Eastern European countries, the Max Planck Institute and Fraunhoffer Institute in West Germany and the national research centers in France. In the other system, scientific research is distributed in colleges and universities, industries and various departments in the government, the state has no concentrated research centers and there are only honorary and consulting academic organizations such as the National Academy of Sciences in the United States, the Royal Society in Britain and the Institute of Scholars in Japan. There are a number of common features in the two systems. In the former, there are also a number of research organizations in the colleges, universities,

government departments and industries; in the latter, the government guides and coordinates basic research through policies and funding and large-scale science projects are in fact still run by the government.

It is still quite difficult to properly evaluate the advantages and disadvantages of the two systems because there are many factors affecting the choice between the two models including historical reasons, social system reasons, economic reasons and the factor of tradition. We should carefully study the characteristics of the systems and absorb useful experiences and we should not give preference to the model of some countries and lightly dismiss the model of other countries. Especially, we should not negate our own experiences and the foundation obtained through 31 years of practice with some foreign experiences. No matter in which country, there are always reasons to opt for a certain system. Generally speaking, a country is always trying to compensate for the shortcomings of its system by various means and is also constantly changing its system locally or globally based on the development situation. A system is not absolutely rigid and does not decide everything.

We need to make an analysis of our own situation. In 1928, China established its Central Institute of Research. One month after the birth of the new China, the Academy of Sciences was established on the basis of the takeover of the Central Institute of Research and the Peiping Institute of Research. Although the Academy of Sciences was small at the time, it had the best scientists in China. Research organizations in industrial and defense departments were almost nonexistent at that time. Many institutes for higher learning had little or no scientific research. Hence, the absolute majority of scientific research in China at that time was concentrated in the Academy of Sciences. In 1953, the expenditure of the Academy of Sciences was 59.79 percent of the total national scientific research expenditure. In the early stage of the national construction, a number of urgent tasks including antigerm warfare, antibiotics development, nodular cast iron technology, and investigation of the source of locust in nine eastern provinces in China were all conducted mostly by the Academy of Sciences and encouraging results were obtained. The establishment of the academic departments in the Academy of Sciences and the 12-year national science and technology plan centered on the academy having had extremely important effects on the promotion of science and technology in China. In the 1905's, research organizations in industrial and defense departments were gradually established and research in institutes of higher learning enjoyed relatively great development. But some of the vital and pivotal problems of an integrated or pioneer nature were still shouldered by the Academy of Sciences, examples are key elements, material, measurement technique and basic theoretical studies in the development of the atomic and hydrogen bombs, the development of artificial satellites, and the separation of Baotou rare-earth mineral Panzhihua vanadium, titanium and iron ore. To fill up voids in China, the Academy of Sciences has also developed transistors, accelerators, electronic computers and later lasers, optical fibers and sinar devices. Large-scale general surveys were also organized by the Academy of Sciences, including surveys of Qinghai-Tibet plateau, loessial plateau, Xinjiang, Heilongjiang river valley, south China tropical and subtropical zones, desert, glacier, tundra, salt lake and ocean, and the compilation of fauna, flora, and other maps and charts. This provided scientific

basis for the rational development and integrated utilization of China's natural resources.

The scientific research system in China, including the system of the Academy of Sciences, could indeed use some improvement and perfection. But the "Great Cultural Revolution" severely interfered and disrupted the improvement of the research system, more than 60 percent of the research organization under the Academy of Sciences was handed over to defense and industrial departments and local areas, and the academy was left with only the research institutes in basic sciences such as mathematics and astronomy and a few technological sciences. The system was in shambles. The research organizations transferred out of the academy could not fully function and some could not even conduct normal scientific research. For example, after the Wuhan Institute of Aquatic Biology was turned over to the local area, its activity was limited to Hubei Province. After the Institute of Physiology was turned over to Shanghai Municipality, it was very difficult for the institute to conduct research on the physiology of plateau regions. Some institutes were turned over to defense departments but their scope of study had originally not been limited to military subjects. Because of these reasons, these institutes had to return to the Academy of Sciences one after another after the fall of the "gang of four." In the spirit of learning from the previous experience, it is beneficial to review this part of history today.

Judging from the experience of the last 31 years, the Academy of Sciences has played the role of a general center for natural science research in China and there is the need for it to continue this role in the future because of the following reasons:

1. Science and technology standards in China are underdeveloped and there are not many trained personnel. In order to satisfy the needs of national construction and catch up with the pace of international science and technology development, it is necessary to concentrate the limited manpower toward conducting specialized research.

2. Today because of our limited national resources, it is impossible for us to install many sets of large and expensive equipment. Only one set of equipment can be installed in a research center to be used by all the relevant units in China.

3. Many major scientific and technological problems in the economic construction and defense construction are of a general nature and require the cooperation of many scientific fields and military services.

4. New fields in science and technology continue to emerge on the international scene. In order to develop new fields in science and technology, it is necessary to concentrate a group of high caliber trained personnel and it is also necessary to accumulate the results of basic research.

5. The nation needs an academic organization for domestic and international academic exchange.

6. The nation needs an organization that can provide consultation and scientific verification of important state policies and can play the role of a science and technology staff department for the party and the government. There is also the need for an authoritative academic appraisal organization.

The Academy of Sciences is not only a general research center but is also the nation's highest academic organization in natural sciences. This was stipulated in the Constitution and the organization act of the State Council approved in the First National People's Congress.

The status of the highest academic organization is not in its administrative power but in its guiding and leading role in academics. The reason that the Academy of Sciences is the highest academic organization in the nation is because it has the following qualifications.

1. Members of the scientific council of the Academy of Sciences represent the most outstanding scientists of China. The council consists of not only scientists from research institutes in the academy but also scientists from all over China. In the past, less than 40 percent of the council members were scientists from the academy-operated research institutes and more than 60 percent were scientists from departments and units outside the academy. The recently expanded scientific council maintains more or less the same ratio. It is through the organization of the academic departments in the Academy of Sciences that these council members play their leading role in various scientific fields.

2. The development of science and technology in China is advanced through the high quality scientific research conducted at research institutes of the Academy of Sciences together with the contribution of other branches.

3. By organizing various academic activities, the Academy of Sciences promotes the connection and exchange of various branches, analyzes the trend of development of scientific fields in China and abroad, and explores the direction for academic activities.

In view of the reasons given above, it is appropriate for China to combine its highest national academic leading organization with the actual implementation of scientific research.

Emphasize Fundamental Research and Emphasize Improvement To Serve the National Economic and Defense Construction

To study China's scientific research system, we must begin with the actual situation in China. China has a large population and a weak economic force. In terms of science and technology, China on the whole is relatively underdeveloped but we have already established a science and technology base that has a good foundation and is relatively complete in terms of scientific fields. We can rely mostly on our own power and independently solve a series of scientific and technological problems in our national construction and we can fairly quickly catch up with the pace of international progress in science

and technology and develop new technological fields. It is dangerous to overestimate our ability but it is also improper to underestimate our ability.

Because our scientific and technological standards are relatively low, we need to learn and introduce advanced foreign technology. But we cannot rely completely on foreign nations to solve the complex economic and defense problems of a large country like ours, we need to have our own scientific research. In view of the situation in China, the technological level and economic development cannot be improved without applied research and the backward situation in applied research and technological development cannot be improved without a reserve of basic research to explore and pace the way. As a unit exclusively engaged in scientific research, the Academy of Sciences has assumed both responsibilities in the past and it now seems that there is no need for change. Of course, the Academy of Sciences is not directly involved in teaching and and production assignments, and should do more fundamental and improvement work both in basic research and in applied research. This is because:

1. Practical experience of our own and other countries has shown that, without the backing of certain theoretical sciences, fundamental advance and innovation in technology are impossible. Therefore, fundamental research is receiving more and more attention from governments and the science and technology profession. In many industrially developed nations, the expenditure on basic research is approximately 15 to 20 percent of the nation's total scientific research expenditure. Since the 1970's, Japan, considered by others as a country that only stresses technological research, has consistently invested more than 12 percent of its scientific research expenditure on fundamental research, the percentage was further increased to 16.2 in 1979. In China, on the other hand, the fundamental research expenditure is estimated to be only 3 to 5 percent of the total national expenditure on scientific research. Although there was some recovery of fundamental research at the Academy of Sciences after the fall of the "gang of four," only 5 to 10 percent of all its scientific research today is fundamental research. There are three reasons why the fundamental research was not developed more quickly. First, people engaged in fundamental research must have a certain aptitude in fundamental theory but many people were delayed by the 10-year turmoil and it has been difficult to build up this force quickly. Second, many researchers have spent a long time doing development research and cannot switch over right away. Third, because even today fundamental research is constantly criticized and blamed by various people, such as "too much fundamental research," "unpractical" and "we should first and foremost develop technological research," and researchers engaged in basic research cannot help but feel the pressure. Actually basic research is not so esoteric as some people have imagined and it is not always far removed from production. For example, research projects such as "toad without a maternal grandfather" conducted by the famous Chinese experimental biologist Zhu Xi [2612 3156] appear to be totally meaningless in terms of production, but using frog, fish and silkworm as subjects for parthenogenic development research, Zhu Xi made important theoretical and experimental contributions to the development of biology which were later applied to actual production. Zhu's analysis of the ookineisis rhythm in his earlier research successfully laid the theoretical foundation for the subsequent artificial cultivation of eri-silkworm. The artificial

synthesis of insulin is not only theoretically significant, but, because of the need for synthesis, it has also promoted the production of many other biochemical reagents and directly promoted later research in polypetide compounds and has made theoretical and practical contributions of international standards. The study of elemental organic chemistry led to a series of fluoride compounds and a fluoride chemistry industry emerged from it. The long-term study of the growth of fish in Chang Jiang has provided a scientific basis for the question of whether Gezhou Dam affects the hatching of migratory fish. There are many more examples like these.

2. Because of negligence on fundamental research for many years, China has suffered greatly. China and Japan began their respective research on semiconductors at about the same time and China succeeded in the experimental production of a transistorized computer before Japan did, and China successfully developed a laser less than 1 year after the first laser came on the international scene. Today, China has substantial production in its semiconductor industry, computer industry and laser industry and has tens of thousands of production workers in these industries, but we have fallen far behind international standards in these areas. The reasons are insufficient fundamental research on key problems and weak applied research.

3. There should be rational division of work and collaboration between the five branches of China's science and technology ranks and unnecessary repetitions should be avoided. Today a scientific force 10 times that of the Academy of Sciences is working in various industrial departments and local research institutes to solve applied and developmental research problems to serve immediate, short-term and medium-term production assignments. In terms of the national science research layout, more work on systematic basic research and medium-term and long-term applied research, development of new theories and new technologies and a more active effort to build up the nation's scientific reserve cannot only avoid repetition and confusion but are also beneficial and necessary for the overall development of science and technology in China. The research institutes of many industrial departments are making precisely the same requests to the Academy of Sciences. As scientific research develops in industrial, defense and local departments, these departments can also carry out some fundamental research within their ability and at the same time they can still submit some subjects of fundamental investigation to the Academy of Sciences and institutes of higher learning to improve mutual connection and collaboration.

Based on its nature and mission, the Academy of Sciences has determined its direction of effort: emphasizing fundamental research and emphasizing improvement to serve the national economy and defense construction, known as the "two emphases, two services" for short. As stated above, this policy is a correct one. It is precisely through the two emphases, the Academy of Sciences can provide better the two services. The "two emphases" are prerequisites for better "two services," and the latter relies on the further promotion of the former. Judging from the work done by the Academy of Sciences in many previous years, the method of combining scientific research development with solving practical problems in national construction is an effective method.

Many scientists have repeatedly discussed the specifics of this policy, we now summarize them as follows:

1. The Academy of Sciences engages mainly in the research of fundamental sciences and some technological sciences. In terms of research work, the Academy of Sciences mainly assumes fundamental research and applied research (including applied fundamental research and technological research) assignments and also assumes some development work. In the entire research field, fundamental work, i.e., fundamental research and applied fundamental research should be strengthened.

The emphases in fundamental sciences are 1 academic fields with strong leaders and high quality results and international influence such as biochemistry, neurophysiology, palaeontology, natural organic compound studies and some branches in theoretical physics and mathematics; 2 fields closely related to technological sciences and production technology such as solid state physics, high polymer chemistry, elemental organic chemistry, geotectonics and sedimentation, computational mathematics, and photosynthesis; and 3 new starts and new fields in science such as molecular biology and structural chemistry. In the meantime, there should be active support of interactions between sciences and particularly introducing mathematical and physical theories into various fields.

According to the situation in China, we should also pay special attention to the development of biology and earth science which are the foundation of agriculture, energy resources development and medicine and health.

In the area of technological science, we should strengthen scientific disciplines closely related to energy, material, and environment, make a major effort in new technology development and build a close cooperation with production departments.

2. Actively participate in solving major interdisciplinary scientific and technological problems in national economy and defense construction. Examples are investigation and experimentation in agricultural modernization, energy related scientific and technological research, comprehensive survey of resources and the associated scientific technique, research of new metallic material for the modernization of agriculture, industry and defense, inorganic nonmetallic material and organic material research, research in medicine, biology and earth science, research of population control and population quality, and providing a scientific basis for forecasting natural disaster and man-made hazards.

3. The Academy of Sciences should fully develop the role of scientists and play an advising and consulting role for major policies on national construction based on results from the laboratory and data of comprehensive studies. In the past, scientists of the Academy of Sciences have made important suggestions regarding the integrated utilization of symbiotic mines unique in China and the comprehensive management of Huang He, Huai He and Hai He. In recent years, important opinions have been provided by the Academy of Sciences regarding agricultural development policy, ecological balance,

management policy of the northwest plateau and energy policies. Effort in this area should be developed further in the future.

In the meantime, the Academy of Sciences is carrying out research in mathematics, system science, ecology, environmental science, comprehensive survey, and psychology and will be making contributions to the development of management science and the modernization of national economic management.

4. The Academy of Sciences should strengthen the cultivation of scientific and technological cadres, continuously improve the quality of research and technical staff and deliver trained scientific and technological personnel to other branches. One of the fundamental missions of the Academy of Sciences is to produce trained personnel and it has trained in the past a large number of cadres specialized in new theory and new technology (such as semiconductor, computer, laser and automation) for many departments and units. It has also provided cadres to relevant departments. In the future, large and sophisticated research facilities at the Academy of Sciences should be fully used to attract technical personnel from other units to work together and scientific and technological personnel with independent research ability should be delivered to other units more systematically.

As the entire party and the entire population gradually improve their understanding of the importance of science and technology, as demands on science and technology gradually increase in the national economic readjustment and as the nature, mission and direction of the Academy of Sciences become more definitive, it is entirely possible for the Academy of Sciences to play its deserved and important role in China's scientific research structure. The solidarity and collaboration of the various branches of science and technology in China should also become more and more heightened.

9698
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ACADEMY OF SCIENCES ESTABLISHES POLICY FOR FUNDING ASSISTANCE

Beijing GUANGMING RIBAO in Chinese 28 Mar 82 p 2

[Article: "Procedures of Implementation of Provisional Regulations Governing the Science Funds of the Chinese Academy of Sciences, Passed at the First Meeting of the Science Funds Committee of the Chinese Academy of Sciences, 2 March 1982"]

[Text] The following procedures are specially established on the basis of the Provisional Regulations Governing the Science Funds of the Chinese Academy of Sciences (hereafter referred to as "Regulations"), in order to properly use and manage the science funds of the Chinese Academy of Sciences and to advance the development of scientific technology.

Application for Funding Assistance and Review of Projects and Topics

1. Applications for funding assistance from the science funds for research projects and topics may be submitted at any time. Reviews are conducted according to set schedule. Projects and topics meeting the funding guidelines under the "Regulations," for which specific research capabilities are available but funds are needed for implementation, may be submitted for funding to the Science Funds Committee (hereafter referred to as the committee) of the Chinese Academy of Sciences. Generally, about 6 months are required from the time an application is received by the committee to the time the committee completes its evaluation. Reviews are conducted by the committee in April and October.

2. An application for science funds must be filled out by the researcher in accordance with the format of the science funds application form of the Chinese Academy of Sciences and item 15 of the "Regulations." After review by the research committee of the researcher's unit (or its department in charge of scientific research) and a decision by the unit's leadership as to whether or not to support the research, and his rendering of an opinion as to whether or not certain basic work conditions can be guaranteed, and if all conditions are favorable, the application is then submitted to the Science Funds Committee. Applications should be submitted on No 16 paper and in 10 copies.

3. Evaluation and approval by professionals with interests along similar lines to projects and topics for which funding is requested. After proposals

for research projects and topics are received by the Science Funds Committee, they are usually transmitted separately to related academic-science funds groups for evaluation. Based on opinions as to evalation, feasibility, and overall balance, the various academic science funds groups make a selection of projects and topics for funding. For projects and topics below 100,000 yuan, approval is given directly by the academic science funds groups, and these are reported to the Science Funds Committee for its record. Projects and topics [requiring] over 100,000 yuan are reported back to the Science Funds Committee for approval before transmittal back to the applicants. Because of limitations in the total funds available, projects and topics which have successfully passed an evaluation but do not get final approval are listed as reserve projects and will be given priority consideration in the next go-round.

4. For the benefit of discovery, cultivation of personnel, and development of scientific work in the far border regions, priority consideration should be given, all things being equal, to young scientific and technical workers and those in the far border regions. At the same time, scientific and technical workers in advanced departments, advanced regions, and advanced units are encouraged to cooperate in the research in order to fully develop our scientific and technical potential, advance scientific and technical development, and better serve the national economy and national defense.

5. At the time the projects and topics are approved for funding, the Science Funds Committee and the academic science funds groups will notify the persons responsible for the projects and topics and the units where they are located, and the responsible departments will be informed by copies of the notifications. The involved units and departments should integrate the funded projects and topics into their research plans, strengthen their direction and supervisory inspection, provide full support in terms of personnel and materials, and organize coordination by the administrative sections. The persons responsible for the projects should respect the direction and supervision of their own units.

6. Applications for science funds must be for newly developed research projects and topics. If the research content and adopted research and technical approaches duplicate work by other units in the country, or if research expenses have been arranged through some other means, funding will not be provided under the science funds.

Management of Funds

7. In principle, funds for the support of a project or topic are determined all at once and are allocated in stages. Any surplus is kept for future use, and overruns are not covered. Based on actual conditions, budget plans may be appropriately adjusted on a yearly basis. Surplus funds at the end of the year may be transferred for use the following year.

8. After receiving notification of approval of research projects and topics, the applicants should proceed with their work in accordance with the approved contents. If an applicant does not agree with the approved contents, he should report this to the Science Funds Committee within 1 month for further study and disposition.

9. Funds for the support of projects and topics are transmitted to the units where the persons responsible for the projects and topics are located. The finance departments in the units will be responsible for management of the funds, setting up separate budgets and separate accounting for the funds, which are to be used specifically for the intended uses. Within the guidelines of the finance system, persons responsible for the projects have the authority to allocate the use of the funds.

10. The use of the funds for the support of projects and tasks must be determined very carefully to achieve conservation. Expenditures are limited to those specified under Item 13 of the "Regulations." The following expenditures cannot be included:

(1) Building costs, office maintenance costs, and public affairs expenses.

(2) Wages, wage subsidies, and labor and insurance welfare expenses.

(3) The cost of joint-use instruments and equipment where they are not in use by the funded projects and topics over 60 percent of the time.

(4) Instruments, equipment, and materials already available prior to the application.

11. Accounting reports should be compiled yearly on expenses charged to the science funds and sent to the Science Funds Committee on 15 January following the end of the year. A final total accounting for each research project and topic should be compiled after completion of the research work, should be submitted to Science Funds Committee for verification. Leftover funds generally can be kept in the unit to be used as research funds. Priority use (generally not less than 50 percent) should be for research projects conducted by the person responsible for the project supported by the science funds. If the leftover funds are relatively large, the Science Funds Committee has the authority to take back a portion for the support of other projects.

Supply of Equipment and Materials

12. Equipment and materials needed for the project and topic funded by the science funds will be requested through normal channels by the unit where the researcher works. Separate accounting records should be established for such equipment and materials. The equipment and materials should be properly managed according to the management system for goods and materials.

13. When the research work for the funded project and topic is totally complete, fixed property and leftover equipment and materials should be assigned values and kept in the unit for use, without compensation, and a record of this is to be reported to the Science Funds Committee for its files. If, for any reason, the funded project and topic are canceled midway or the funding is discontinued, unused funds and equipment and materials should be withdrawn and clearly returned to the Science Funds Committee.

Research Results and Work Report

14. After the research work for the science funds-supported project and topic is completed, conclusions should be conscientiously prepared, complete data, drawings, and materials organized, and a research report and academic paper written. These should be submitted to the academic science funds group, the Science Funds Committee, and the management department.

15. The organizational unit or the science organization (such as the science committee) of its upper management department is responsible for evaluating the research results of the funded project and topic. Results of this evaluation are to be reported to the academic science funds group, Science Funds Committee, and the management department. The Science Funds Committee and the science funds group will select results of important significance, organize their evaluation, compile on a regular schedule the results of important scientific significance or practical value, and recommend them to the relevant departments.

16. The persons responsible for the projects and topics should periodically submit work reports to the concerned academic science funds group and the Science Funds Committee. Progress reports should be submitted every 6 months. Annual work reports should be submitted at the end of the year. Final work summary reports should be submitted when research projects and topics have been completed.

17. Research results (including treatises, reports, etc.) should be published as quickly as possible. The publication should clearly state that it covers a project funded by science funds of the Chinese Academy of Sciences.

18. Applications for reward, transfer of possession, and patent for the results are processed according to appropriate state regulations.

Other Points

19. Fund allocation requests, research reports (semiannual, annual, and final), annual accounting reports, final accounting, result registration forms, and various formats and requirements of forms and reports are transmitted along with notifications of approval of projects and topics.

20. These procedures are effective on the date of publication. They will be revised and amended as experiences of their implementation are summarized.

Science Funds Committee, Chinese Academy of Sciences: Key Principles of Support for Project and Subject Applications for Science Funds (2 March 1982)

Science funds are used mainly to support our country's basic type of work in basic and applied research in natural sciences. Emphasis will be on the support of subjects with important scientific significance, with independent academic understanding, and where results are anticipated on a short-range basis. Support will also be given to fill gaps in important subjects, to strengthen weaknesses in branch subjects, and to [contribute to] the growth of fringe subjects. Priority support is given to the following types of topics:

1. Basic research topics closely related to the modernization of socialism in our country.

2. Basic research topics in various subjects designated for important development in the near term.

3. Topics beneficial to the cross integration of various sciences and various technologies and to the development of fringe subjects.

4. Topics beneficial to the promotion and application of new technology.

5. Topics beneficial to the promotion of cooperation between various units and to the full utilization of existing facilities.

5974
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TAILORING S&T MODERNIZATION TO LOCAL CONDITIONS

Beijing ZIRAN BIANZHENGFA TONGXUN [JOURNAL OF DIALECTICS OF NATURE] in Chinese, Vol 4 No 1, Feb 82 pp 30-38

[Article by Li Chang [2621 2490]: "Developing Science and Technology in a Big Way Is an Urgent Task of Building a Modern and Strong Socialist Nation*"]

[Text] Since liberation, China's science has developed greatly. The Academia Sinica and such agencies during the period of the Kuomintang government had only 200-odd researchers. Now, the Chinese Academy of Sciences alone has 118 agencies with a staff of more than 76,000 workers, and among them, more than 30,000 are scientific researchers. In the whole nation, there are 330,000 people specifically engaged in research. This is not a small force and it shows that our nation's scientific research has established a preliminary scale.

But in retrospect of the work during these years, we believe our nation's science and technology as a productive force has not served sufficiently to promote the national economy. Our understanding of the importance of science and technology is also very deficient. We have not elevated science and technology to a position that they should enjoy. Aimed at this situation, Comrade (Hu) Yaobang mentioned three aspects: First, we must improve the whole party's and the whole people's understanding of the importance of science and technology. Second, the Central Committee must establish correct guiding principles and policies for science and technology. Third, scientific and technical work must make major contributions. Only in this way can the people's understanding of the importance of science and technology be improved and the speed of development of our nation's science and technology be quickened. Below, I shall emphasize the problem of understanding the importance of science and technology and the question concerning the guiding principles to develop science and technology.

(I) The Problem of Understanding the Importance of Science and Technology

The Central Committee places a lot of emphasis on science and technology. In 1964, Premier Zhou proposed the question of modernization of science and

*This is an excerpt of the speech given by Comrade Li Chang at the Chinese Communist Central Party School on 10 April 1981.

technology at the Third National People's Congress. But the "Cultural Revolution" interrupted the course of realization. Later, Premier Zhou pointed out this problem again in 1975. In 1975, when Comrade (Deng) Xiaoping managed the affairs of the Central Committee, he again emphasized scientific and technical work. In July 1975, I followed Comrade Yaobang to work at the Chinese Academy of Sciences. Not long afterward, Comrade Yaobang took charge and Comrade (Hu) Qiaomu, et al, participated in drafting a "general report and guideline." When the State Council discussed the "general report and guideline," Comrade Xiaoping emphasized that modernization of science and technology serves a very important function in the four modernizations, and this link must be grasped. Of course, because of the "opposition to the rightist reverse the verdict movement," the course of realizing the four modernizations was interrupted. After crushing the "gang of four," the Central Committee was clearer on this point. On 30 May 1977, the Politburo of the Central Committee specifically discussed the problem of science and technology, and decided to hold a national science conference. In March 1978, Comrade Xiaoping further pointed out clearly to the National Science Conference that the key to the four modernizations is the modernization of science and technology. hhis has elevated science and technology to a very high level. But, even though the responsible comrades of the Central Committee have again and again emphasized the importance of science and technology, some of our comrades still do not have a sufficient understanding of their importance. Even after they have suffered, their understanding still did not deepen. What is the cause? Of course there is the "leftist" influence here. But, after correcting "leftist" mistakes, will the understanding be sufficient? Not necessarily so. I feel that there are still profound historical and social causes and there is the factor of understanding. Without seeking the root of these aspects, this problem is still not easy to solve.

1. Historical Reasons

Modern science and technology have developed along with the development of Western capitalist society. They have served greatly to develop the capitalist economy and society. But, because China remained a semifeudal and semicolonial society before liberation, we were not familiar enough with the development of modern science and technology and our understanding was more abstract. We did not feel their great impact directly and our understanding of course could not progress.

Everyone knows the milestone of modern science was Newtonian mechanics and calculus. The formation of modernization was conditioned by the emergence of the capitalist class. It was born in Europe because Europe was the first to change from a feudal society to a capitalist society. Although Europe's feudal society, and the production relations of feudalism were truly established only as late as the 9th to the 11th century, but the emergence of capitalism was relatively early. At the time, the church ruled over the spiritual kingdom of Europe, and at the same time, the church occupied a lot of land of the nations adhering to the faith. Worldly leaders and kings and dukes occupied castles and manors. The world was divided and strongmen ruled independently. Under this situation, commercial production and exchange began to develop slowly. By the 11th century, especially by the 12th century,

European cities and towns appeared on a widespread basis. The Crusades and the discovery of America prompted the rapid development of European industry and commerce. In these newly emerged cities, handicraftsmen, merchants and even apprentices and assistant workers formed the modern capitalist class and the proletariat, and at the same time, intellectuals emerged. Later, the university emerged. Europe was different from our nation. Feudal rule centered in the villages while newly emerged cities were places of concentration of the capitalist class. And it was these cities that became the arena which produced modern science. On the one hand, prosperity of the urban economy created the need for science, and at the same time, the democratic revolution of the European capitalist class was also centered in the cities, and science became the sharp spiritual weapon of the capitialist class opposing feudalism and the church, thus the development of science was pushed forward. On the other hand, the development of production was also helped by science and technology. The steam locomotive was invented in the 18th century, followed by ships, trains, the telegraph, and also what the Chinese called the foreigner's armored soldiers, battleships and artillery. This greatly increased the productive strength of the capitalist society, and thus capitalism was able to conquer large colonies, semicolonies and satellite nations.

By the second half of the 19th century, the function of science became more visible. Science could march ahead of production, and such a process began--first science, then new technology, and then industry. For example, the two major industries of the second half of the 19th century were both begun by scientific research. One was the electrical industry. First there were the principles of electromagnetism, and then these principles generated electrical technologies, and then an entire electrical industry emerged. The other was the chemical industry. Similarly, first there was modern chemistry which developed chemical analysis and synthetic technologies and it finally build a chemical industry.

Marx and Engels made such a statement in the "Communist Manifesto": "The productive force created by the capitalist class during its less than a century of capitalist rule is much greater than all of the productive forces created during all past periods." Then, how did the capitalist class develop its productive force so greatly? Marx said: "Unless it continues to revolutionize production tools, production relations and all social relations, it will not survive." In such fierce competition in the capitalist class, science and technology continued to change the production tools, and science and technology became the tool with which the capitalist class to become rich, and they served as its meritorious workers and founding fathers. We can see that in the Western capitalist world, scientists, investors and professors are widely respected and praised in the society, and they have become society's knights, heroes, virtuous persons and saints. Even today, Great Britain still bestows the honorary title of "sir" upon scientists who have made contributions.

Here is some information on the function of science and technology in increasing material wealth. In the five nations of Great Britain, the United States, France, Germany and Japan, the annual average per capita income in 1850 calculated in constant 1926 prices was $235. By 1950, after 100 years, the per

capita average was $861. By 1973, before the petroleum crisis, the per capita income was $4,606. From 1850 to 1973, a period of more than 120 years, average per capita income increased from $235 to $4,606, and so much wealth was created. Let us talk about another concept. From 1860 to 1950, the annual average personal income in Western Europe increased at a rate of 1 percent. From 1950 to 1970, during the 20 years after the war when capitalism developed the fastest, the rate was 4.5 percent. Therefore, the function of science and technology is very well understood by the capitalist class and it has long been accepted by society.

In contrast, the situation in China during this period was vastly different. During the Sung and the Yuan Dynasties, we were still leading in science and technology, but after the 16th century, we fell behind. Why was this so? In 220 B.C. the Qin and Han Dynasties began establishing a unified feudal empire. For more than 2,000 years, there were 3 divisions (4 divisions if we include the chaos of the warlords during the beginning years of the Nationalist government). The duration of such divisions was all very short. Most of the time, China was a unified feudal empire. The economic foundation of this large unified empire was the natural economy of the small farmers. The emperor relied on feudal exploitation and he did not want to develop a commercial economy. All imperial dynasties emphasized agriculture and suppressed commerce. Industry frequently was established by the government and products were not supplied to the civilian population. The father of the author Cao Xuejin of "The Dream of the Red Chamber," Cao Fu, served as the Jiangning textile manufacturer, an industry of the emperor. Our nation has always despised technology and regarded technology as "insignificant skills." Especially during the later period of the feudal society (after the Ming Dynasty), literary inquisition was rampant and people's thoughts were imprisoned. To foreign nations, China was basically closed, and the economy and culture did not develop. Although large cities emerged in our nation early, like the city of Hangzhou (then called Linan) during the Southern Sung Dynasty which had already become a large city with a population of 1.2 million, China's cities were centers of feudal rule (from the emperor to the bureaucrats to the landlords). And in recent times, the cities were still centers of government of such rulers with the participation of imperialism, unlike European cities. China's democratic revolution of the capitalist class was also centered in the farm villages, unlike Europe where the cities were basically the center of such revolution. Chairman Mao created a lot for the democratic revolution. The common truths of Marxism-Leninism were combined with concrete practices of the Chinese revolution and they produced Mao Zedong Thought, and the road to victory of the Chinese revolution was found--to use the farm villages to surround the cities, and the cities were finally liberated. But objectively, some problems were created, and we were unfamiliar with recent and modern science and scientists, and our understanding of the importance of science and technology was insufficient, thus, the policies concerning scientific and technical personnel easily made "leftist" errors, and the intellectuals became the targets of reform. We did not have a history of relying on science and technology to promote the economy. We did not have a tradition of utilizing science and technology to develop the economy, therefore, although we have repeatedly said that science and technology are important, it is not easy to truly accept it. This is the historical reason.

2. Social Reasons

After liberation, our nation's society underwent a fundamental change. A socialist nation led by the party was established. And during the past 30 years, industrial and agricultural production and scientific education all developed very quickly. This is affirmative. Now, fixed assets of the system of ownership by the whole people have already reached over 40 million yuan, an increase of more than 20 times over that before liberation. But, we must realize that after liberation, our nation's major industries and scientific research mainly paralleled foreign imports or the knowledge was mostly learned. Our science was not mostly established on our industrial foundation. Our industry was not developed under our own promotion of science and technology. These two aspects are unlike those in foreign nations which have been closely combined for several hundred years. This is one aspect.

Second, in the past, our economic management system also had problems. We practice a command-type planned economy under centralized authority. For a long time, we have committed "leftist" mistakes of pursuing high accumulation, high speed, low gain and low consumption. We do not recognize production materials as commercial commodities. The scope of commodities has been drawn narrower and narrower. The regulatory function of the market has become smaller and smaller. We always fear that a commercial economy will develop. This type of economic management system of ours originated from two sources: One was based on the locality's supply system (at the time, this method served an active function). The second was learning the backward things of the Soviet Union of the 1950's. In this way, production became unified procurement and guaranteed sales. Things were done according to the directives of higher authorities. We did not care about economic gains and we did not pursue product quality. There was no competition, and the inner economy lost the motive force to utilize and promote science and technology, thus, production technology became stagnant.

The third problem among the social causes was that after reformation of the ownership system of production materials was completed, we should have centered our efforts on the development of production, but we did not do so. Actually, all of our work was centered around class struggle and political movements, and economic work was viewed only from its political aspect, and it did not reflect the basic laws of socialist economic development and it did not rely on science and technology. Scientific and technical departments did not know what demands the economy made upon science and technology, and they did not understand clearly that they should serve the economy and how they should serve the economy. In this way, it was difficult for the five major forces of our scientific research system, the science academies, the national defense industry system, the system of production departments, the universities and the local scientific research agencies to establish unified cooperation and coordination, and frequently, each carried out its own work and each was separated from the other. Science and technology could not develop and exert their strength, and this helped the growth of departmentalism and the local ownership system. The situation became even worse during the "Cultural

Revolution." Some people even said that "ever since Pangu created the heavens and earth, we planted the fields without science." Later, private ownership of knowledge was criticized, and people said "more knowledge means being more reactionary." Under this situation, how could science and technology be emphasized? This is the social reason.

3. Reasons of Understanding

Originally, natural science was a foundation of dialectic materialism. Chairman Mao also said many times, philosophy is the generalization of natural science and social science. This shows that Marxists should enrich and develop dialectical materialism from social struggle and from advances in natural science. But, because the world communist movement of the past was mainly in the stage of seizing political power and communists utilized Marxism-Leninism mainly in class struggle, consideration of natural science was scarce. In the history of the international communist movement, Engels was the one who studied natural sciences the most. He once said: "Like idealism, materialism also underwent a series of developmental stages and materialism must change its own form along with every major development in natural science." Lenin also said: "Materialism believes that the world is richer, more lively and more varied than what it appears to be, because whenever science develops one step further, a new aspect of the world will be discovered." To protect dialectic materialism, the question of the conversion of elements following the discovery of radium and electrons could not be explained by classical physics. Physics encountered a crisis, and some people seized the opportunity to advocate that "materials are destroyed." Lenin wrote "Materialism and Empiro-criticism" and summarized some of the achievements in natural sciences at the time. But Lenin's major effort was directed towards leading the Russian proletarian revolution. He did not have more time to study all the developments in natural science that had occurred before his death. And at that time, he had not seen Engles' "Dialectics of Nature" (this was discovered only after Lenin died). As we entered the period of socialist development, we should have emphasized science and technology and the use of new achievements in natural science to enrich dialectic materialism and to use dialectic materialism to guide the development of natural science. But, the Soviet Union did not handle the question of natural science well and it made mistakes, such as blindly criticizing Morgan's genetics theory, Pauling's resonance theory and cybernetics. (Lisenko) and (Leboshinskaya) whom they supported were engaged in pseudo-sciences, and they became a big joke in the world.

Because of the historical and social reasons mentioned previously, our party is unfamiliar with recent and modern natural science. Since liberation, and since the time when the socialist reform of the private ownership system of production materials was basically completed, our party has still not paid attention to using the new achievements of current natural science to enrich dialectic materialism. Chairman Mao was a great Marxist. He wrote the great works "Problems of Strategy in China's Revolutionary War," "On New Democracy" and "On Protracted War." But some of the mistakes in 1958 and especially during the "Cultural Revolution," such as the campaign and the practice of "smelting iron in a big way," could not be understood in view of the level of modern scientific knowledge. This is the first problem in understanding.

Second, we have included scientific experiment as one of the aspects of the Three Great Revolutionary Movements. This saying as seen today is also debatable. Modern science is the product of hard mental labor of scientists over a long period. It must be repeatedly and systematically observed and tested, qualitatively and quantitatively studied from many aspects, and repeatedly proven and examined before it can develop. It is not something that many people can rush over and develop a truth about. Without long periods of specialized research by scientists, there will not be any modern science. Of course, this does not mean that organized collective research under an academic leader is not needed. Neither does this mean opposing the mass line in scientific research. It is a belief that we cannot use the method of mass movement to carry out scientific research. Our cadres have had the experience of fighting to reduce rent for land and interest on loans, fighting for land reform, resisting the United States and assisting Korea, carrying out the patriotic health campaign, and they easily accept the use of the methods of mass movements in scientific research. But the results of this method are not good. For example, when the comrades of the leadership at each level engage in experimental fields for planting, strictly speaking, they are not engaged in modern scientific experiments. Where is the design of the experiment? What problems are to be tested and proven? What are the results? These are all difficult to say. "Taking food grains as the key link" and "the eight point character for agriculture" all lack precise scientific concepts. Up to what level do we consider it a "key link?" Nobody can explain it clearly, and as a result, serious problems raise in practice. Some people have made up their own saying: "When taking food grains as the key link and blindly reclaiming land, when agriculture, forestry, livestock production and sideline production use up all the land, soil erosion occurs, and drought and flooding occur frequently."

The above situation shows that we do not understand the characteristics of modern science and technology. Although the original intension of many comrades were good and they wanted to quickly push China's economy forward, but because these ideas and methods were not suited to modern science, as a result, haste made waste, and China's economic development was delayed. This situation has not been completely solved yet. Some of us do not have a high regard for experts and talented people. Some experts work at jobs they are not trained for, and they are not released even when units that can utilize them want them. Whenever someone proposes to establish a research institute, he wants 300 or 500 people. He does not understand that a research agency does not care how many hundred people it has, what matters is whether it has any high caliber scientists. Achievements cannot be made simply because there are many people.

All of these historical and social reasons and factors in understanding have caused our cadres to have an insufficient understanding of the importance of science and technology. Therefore, our task is to learn recent and modern scientific knowledge of the world well and inherit all scientific culture and spiritual wealth created by mankind. We are a socialist nation. We have this condition and we have this need. The foreign capitalist class has grasped production and exchanged it for profit.

To achieve this goal, foreign capitalists have continued to reform production relations and social relations on the one hand, and on the other hand, they have developed science and technology. Similarly, we should also pay attention to economic gain on the one hand and reform our production relations and social relations to meet the material, cultural and living needs of the people. On the other hand, we must develop science and technology, and we must study natural science well, enrich dialectic materialism and use it to guide the building of the four modernizations.

Although we are far behind foreign nations in science and technology and material production at present, and our understanding of the importance of science and technology is still not sufficient, we must not improperly belittle ourselves and we must not give up. We are the rising sun. Although we have suffered great reverses, the future is bright. We also suffered reverses in the democratic revolution. We carried out a revolution in such a large nation in the East, we took the farmers as the main body of people and the semifeudal and semicolonial production relations as the target of the revolution. Marxism-Leninism did not even tell us how to do it. We explored independently, and naturally we encountered a lot of setbacks. Chairman Mao creatively solved this problem only later. Now, the same problems are being encountered in national buildup. As long as we conscientiously summarize the experience, we will continue to advance. Today, we examine our deficient understanding of the importance of science and technology because we still have confidence to march forward.

(II) The Question of the Guiding Principles To Develop Science and Technology

To develop science and technology, cadres at each level should improve their understanding of the importance of science and technology, but there is still another important question. That is, there must be a set of correct guiding principles and policies that suit our nation's situation. If this problem is not solved, our nation's science and technology will still be unable to develop. The most outstanding aspect of this problem is the question of combining science and technology and the economy. The actual function of science and technology to promote production is also not obvious. From top to bottom, we do not feel that science and technology are a productive force. Of course we have some endeavors that have been done well. The more outstanding achievements have been the atom bomb, hydrogen bomb and satellite). In this question, the target is clearer. The National Defense Science Committee is better organized. Our Academy of Sciences has also participated and has done a lot of work. But generally speaking, some questions on the scientific and technical battlefront in the past have not been clear enough. Recently, several situations favorable to this combination have emerged:

One is that the reform of the economic system has begun to require science and technology, especially in the farm villages. We can say that now, our agricultural production has realized a major breakthrough. In the past, production relations have always walked ahead of procutive forces, "everyone was eating from the big pot," "everyone wants to work but not everyone who attends does any work." This cannot mobilize the productive enthusiasm of the

farmers. After the Third Plenum, procurement prices of agricultural products were raised, market trading in the farm villages revived, emphasis was placed on expanding the autonomy of production brigades, and measures were suited to local circumstances to engage in diversification. Especially since last year, gradual popularization of various forms of the responsibility system of specialized work contract, linking production with remuneration and contracting work to the families, contracting work to the laborers has begun. Each year, over 10 million tons of food grains are imported, enabling the farm villages to rest and build up their strength. This series of measures have caused a great change in our farm village work. The productive enthusiasm of farmers has been mobilized. Thus, the welcomed situation of farmers wanting science and technology has emerged. The enthusiasm of farmers in learning science and technology has increased. Some old ladies in Shandong even ride horse carts to learn techniques of planting cotton. A manager of a seed company in Guizhou who was a university graduate from the agricultural science academy said that whenever he goes into the villages, he is surrounded by farmers asking about this and asking about that. Whatever they said they did accordingly, and they realized bumper harvests. They happily invited us to have a feast to celebrate the harvest. When this was reported to the higher authorities, starting from the party Central Committee, everyone liked to listen to scientists. Recently, Comrade Shishan [4258 1472] of the Chinese Academy of Sciences wrote an article which said that farm village work has broken through 10 restrictions. "Taking food grains as the key link" need not be mentioned anymore. There is a researcher named Comrade Hou Xueyu [0186 1331 3558), who wrote an article in the RENMIN RIBAO and talked about the problem of feeding a population of 1 billion. He advocated macrocosmic food grains and macroagriculture. Macrocosmic food grains means that food grains should not be limited to wheat, rice, corn, but the staple must be expanded to include the eating of meat and woody plants such as chestnuts, walnuts and papayas. Macroagriculture means that besides planting, there should also be agriculture, forestry, livestock production, sideline production, fishery, and insect culture such as sericulture, beekeeping and microorganic cultures, etc. The comrades of the Central Committee liked the articles written by Comrades Shi and Hou. Recently, the Central Committee made a resolution concerning agriculture. It emphasized suiting measures to local circumstances, diversification, fine plowing and fine planting, and it included seven opinions by scientists. The Central Committee believed that they should be listened to and followed. Now, agricultural policies have begun to progress on course. This is a new situation.

Another situation is the establishment of the new 5-year plan. In the past, we seldom considered the factors of science and technology. We only drew up economic plans and we did not mention science and technology, and we did not mention the needs of social development (what are the needs for food, for clothing, for housing, for daily commodities, for transportation during this period, how many schools, hospitals, movie houses, broadcasting stations, etc., must be developed). Therefore, last year, in drawing up the "5-year plan" and the "10-year forecasts," Comrade Xiaoping, based on the experience of foreign nations, proposed that our plans should be a three-in-one development of science and technology, economy, and society. One of my feelings is that we can start out from the needs of social development to determine the economic

plan accordingly to guarantee the realization of social development plans. Then, we can establish plans for science and technology according to the economic plan to guarantee its realization. There is another way, which is to begin from science and technology. First we should find out which natural productive forces can be developed by science and technology in 10 years or 20 years (such as petroleum, coal, hydraulic power, land resources) and to what degree, then we can determine the economic plan and finally draw up a plan for social development. The Soviet Union followed the latter way. If we use both of these methods and combine them together, I believe this will be a major breakthrough in our planning work. Including our plans for science and technology in the entire plan by these methods would fundamentally guarantee the development of the function of science and technology and this will be a big step forward.

Recently, the Central Committee proposed further that science and technology, the economy and society must develop in a coordinated manner. This is the fundamental guiding principle in developing our nation's science and technology. The proposal of this guiding principle means that our nation's science and technology has entered a new era. If we can conscientiously implement this guiding principle, our science and technology will change fundamentally. Our economic development and social development will also undergo a great change. We must have a sufficient understanding of the important significance of this guiding principle. Not long ago, the Central Committee Secretariat heard the reports by the Chinese Academy of Sciences and the State Scientific and Technological Commission and approved the two "general report and guidelines" they proposed. The Central Committee Secretariat also approved the basic guiding principle for the development of science and technology proposed by the State Scientific and Technological Commission: First, science and technology and the economy and society should develop in a coordinated manner, and the promotion of economic development should be the foremost task. Second, emphasis should be on strengthening the study of production technology, technologies should be accurately selected, and a rational technological structure should be formed. Third, development and popularization of the technological processes in factories and mines should be strengthened. Fourth, basic research must also develop gradually on the basis of maintaining a stable foundation. Fifth, learning, digestion and absorption of foreign scientific and technological achievements should be important ways to develop our nation's science and technology. According to the guiding principles approved by the Central Committee, I feel that in execution, attention should be paid to the following problems:

First, on the entire battlefront of science and technology, we must pay special attention not to spend all our efforts in pioneering sciences. We must pay attention to those broad, abundant and frequently encountered problems and those projects that truly have economic benefits. We must not be in a situation where we can develop advanced alloys but we cannot guarantee the quality of ordinary steel materials. Scientific research work must be practical and must truly pay attention to economic gain to serve the needs of developing the economy, to satisfy the needs of the material and cultural life of the people. We must exert efforts to solve the problems in clothing, food, housing,

daily commodities, transportation, in the development of education, culture, sanitation, in resisting natural disasters and in protecting the society and national security.

Second, we must pay attention to selecting the right technological structure, and establish a technological system that suits our nation's situation. If we do not start out from our nation's situation but transplant foreign practices, they will not work. Take agricultural modernization as an example, some comrades who went to the United States to visit have returned to advocate ways of agricultural modernization according to the situation in the United States. First, they advocate mechanization and mechanization of all operations. The machinery and equipment of one farmer in the United States costs $40,000 to $50,000, and on the average, they outnumber workers. Second, they advocate specialization, dividing the fields into corn belts and wheat belts. In this way, airplanes can be used to sow and to spray farm chemicals. Third, they advocate socialization. There are transportation companies which will respond after one phone call. When a farmer wants to spray insecticides, one phone call will be sufficient to obtain an airplane to spray farm chemicals for you. Thus, some of our comrades said, if China wants to realize agricultural modernization, it must first develop mechanization. Actually, this view is not entirely correct. This is because there are different types of agricultural modernization in the world. They can generally be divided into three types. One is the type used in nations which are relatively developed industrially and which have a lot of land but few people and insufficient labor forces, such as the United States, the Soviet Union, and Australia.

These nations mainly rely on agricultural mechanization to increase the labor production rate. The second type is used by nations with more people and less land, such as Japan, which emphasizes the use of biochemical measures first, i.e., improving seeds and applying chemical fertilizers with the goal of increasing unit yield. The third type is found in nations with insufficient cultivated land and labor forces, such as Western European nations like France and West Germany which have a better industrial foundation. Their way is to develop machinery technology and biochemical techniques simultaneously. The situation in each nation is different and the methods used are different. What about us? The main portion of our agriculture is in the eastern part and the central part. The population here is very dense. There is a lot of labor force, and basically our agriculture belongs to the Japanese type. We just said that mechanization requires a lot of investment. The money relies mainly on personal savings of farmers. Mechanized agriculture is basically petroleum-based agriculture. We cannot afford to use too much oil. Therefore, most of the regions in China cannot emphasize mechanization as the main effort, thus it is better to take biochemical measures as the main effort. Of course, this does not mean that our agriculture does not need mechanization, it means that our agricultural machinery must also be suited to local circumstances. The Chinese Academy of Sciences and the Heilongjiang Provincial Committee jointly established a comprehensive experimental base for agricultural modernization in Hailun County. Here, a definite number of combines were needed. After wheat and beans ripened, combines must be used to harvest them, otherwise, those left on the ground could not be harvested. The

second type of equipment is hand tractors. Because hand tractors have many uses, they can be used in large field operations, they can be used for transportation in the fields, and they can be used for operations in the drying yards. The type of large American machinery that is highly efficient and can complete such a little bit of farm work in no time, is not used many times a year, thus such machinery is not worth it. In the United States, corn fields cover several states, the maturation periods in the north and in the south are different, and large machines can traverse from south to north continuously and they have more uses. Our nation is spotted with small fields. We plant flowers, till and plant crops together, and all kinds of crops are planted together. Those large machines cannot do the job. In industry, our nation also has its characteristics. Our nation has a large labor force, wages are low, and there are many unemployed youths. We must develop more labor intensive industries. Therefore, in this sense, the technological structure must be selected well.

Third, the understanding of modernization of science must be accurate. Modernization of science means that we should research those problems that modern science has not solved. Theoretical research should be creative. It must have academic value. Completely repeating what others have done is meaningless. We can select large or small subjects, and achievements can be made at different times. But, it will not work if you engage in theoretical research without creativity. First, the subject must be modernized. In experimental sciences, modernization means that we should have modern experimental means, otherwise it is very difficult to develop modern experimental science. For example, in high energy physics, if there is no high energy accelerator, you will not be able to perform experiments. And if you want to study it, you will have to go to foreign nations to perform the experiments. Viewing the present situation, our academic standard is not high in experimental sciences but in those theoretical or regional sciences, such as mathematics, theoretical physics, biochemistry, geology and biology. Some of them have reached the world level, like artificial synthesis of insulin. We also possess some achievements which are of world standard in regional sciences, such as geological mechanics of Li Xiguang [3621 0934 0342] which foresaw our nation's eastern oilfields, geochemistry which explained the cause and analyzed the characteristics of the Baotou Iron Mines, where foreigners cannot catch up with us. Again for example, foreigners say that there are only 80 species. Our survey listed more than 400 species. This is first hand information and nobody is as good as us. The Himalayas affect the weather of the whole of Asia and even the world. In the study of the Himalayas and the Qinghai-Xizang Plateau, we are the masters, and our achievements are authoritative.

What then is modernization of technology? It is nothing else but the technology which can realize the greatest economic gain. It does not have to be a pioneer technology and the most automated. When the conditions are not present, the most advanced things may not produce the best economic result. For example, our nation leads in the use of marsh gas as a source of energy in farm villages. In the whole world, there are two nations that are carrying out such projects in a big way, one is us, and the other is India. It is internationally recognized that India is behind us. India is developing marsh

gas mainly by relying on foreign cooperation. The degree of mechanization is very high. The price is very high and a lot of investment is required. We do not need that much investment. Our projects easily produce results and they are commonplace. Therefore, technological modernization must be suited to our nation's situation and it must consider economic gain. It must be based on our nation's mineral resources, land resources, biological resources, and manpower resources to establish our own technological system.

Fourth, to strengthen technological development of factories and mines, there is a fundamental concept that must be changed. During the 1950's, we learned a backward concept from the Soviet Union. We believed that the technicians in the science office of factories belonged to nonproductive personnel. The total number of nonproductive personnel in a factory cannot surpass 18 percent, and the number must be limited. This was wrong. I went to visit the Philips Company of Holland. Research on the electron microscope that they manufacture began in 1943. Their company had a display hall. It was like a museum of the electron microscope because it showed what the first electron microscope was like, how it was improved later and the electron microscope of today. Because they have special personnel conducting systematic research, their products are of the best quality. Thus, we should not regard technical personnel as nonproductive personnel. It is precisely because of the work of these technical personnel that their products are able to become what they are today. At present, the general trend of foreign manufacturing companies is having a greater and greater percentage of technical personnel. Their production is developing more and more. We regard technical personnel as people not engaged in production. This violates facts and also limits the development of technology and production of factories and mines. This backward concept must be changed. The percentage of our technical personnel should gradually increase.

Fifth, there must be an overall understanding of the function of basic research. Some people believe basic scientific research mainly serves a function of scientific preparation (after completing research, the results can be applied in production when necessary). This statement is correct but not sufficient. The so-called preparatory function has many meanings. One is that there must be a group of scientists with a relatively high academic caliber, and when necessary, they can join in researching major scientific and technical problems. For example, some of our scientists who studied elementary particles later wanted to develop the atomic bomb, thus these people were strategically transferred. Without such a theoretical team as reserve, the atomic bomb would not have been developed. The second is that certain academic fields must have basic research, and a definite standard must be achieved, thus when a major practical problem has to be solved, such researchers can provide advice and suggestions. But this preparatory function refers mainly to a service that will be performed starting from tomorrow. But basic research not only serves tomorrow, it also serves today. There are also two major functions. One is that it can improve the standard of our higher education and the theoretical standard of our scientific and technological circles. When the entire academic level is elevated, the understanding of problems and the views of problems will not be the same, and instruction will be better. Now we are training graduate students. We must gradually train

masters and Ph.D's. Only by developing basic research in a big way and by elevating our nation's academic caliber can we train high quality scientific talent. The second is that some results of modern basic research can quickly be assigned to produce new technologies and they can be applied immediately, such as genetic engineering. Therefore, it is not enough to say only that basic research can serve a function of scientific preparation. This belittles its function. The function of basic research must be sufficiently understood.

Sixth, we must change the attitude of emphasizing the purchase of whole sets of equipment and neglecting the purchase of patents. How to take over other people's technology should be our goal. We should import sample machines and imitate them by manufacturing them, or purchase technological patents and digest and absorb them so that they will become a component of our technological system. Foreign patents are usually for several years. After these several years, the patents are no longer exclusive, and everyone can use it. There was a period which we did not know and we paid for it without realizing it. These were all cases of being cheated.

Also, after introducing patents, we must also provide funds to create conditions so that the patents can serve their purpose. We also must have matched facilities. Take Japan as an example. From 1955 to 1958, it spent $15 billion buying foreign patents. To use and digest these patents, Japan spent another $50 billion, but the result was a saving of money and time. If Japan relied completely on its own efforts to develop such patents, it would have spent $150 billion and 10 years time, but the total purchasing cost was only $65 billion and the patents were obtained within the year. Therefore, the Japanese are still smart. What does this illustrate? This means that when we can afford to buy the horse, we must also be able to fit the saddle. Only in this way can we develop the function of imports.

Also, imported technology must be matched with our own research and development. Otherwise, foreigners will block us in certain key technologies, such as large-scale integrated circuits. When our 4K level integrated circuits had not reached the acceptable standard, foreigners would not sell us 4K equipment. When they heard that the Chinese Academy of Sciences made a breakthrough in 4K, they were willing to sell us low grade chips and equipment. Because we did not develop an acceptable magnetic disc which is the key peripheral equipment of computers, we asked a relatively friendly foreigner to sell us the patent but he refused. Therefore, everything must be done by relying on our own abilities. Without abilities, others will take advantage of you.

The guiding principle of developing science and technology is already clear, but to implement this guiding principle, there is still a lot of work to be done. For example, we must draw up the 5-year national economic plan and the annual plans which combine science and technology and economic and social development. We must reform the scientific research system. The distribution and utilization of scientific research funds must be more suited to the implementation of these policies. There must also be corresponding measures for cooperation in scientific research and academic exchange. We must adhere to

scientific ethics, establish a good academic environment, and the party should strengthen and improve its leadership of science.

There is another thing that is very important. This is to absorb scientists and let them participate in leadership work. Recently, the State Council decided to establish a center for the economy of technology. Special research agencies involved in the economy of technology are coordinated through this center to help the premier study related questions and to provide advice and opinions. This center consists of three groups of people: those who understand technology, those who understand economics, and those who understand systems science and management. It seems that with such a scientific and technical center beside the premier, science and technology have entered the seat of government. A province should also do this; science and technology should also enter the provincial office building.

Absorbing scientific and technical personnel to participate in party administration at each level will not present any difficulty in leading production, but will produce practical results. Comrade Wanli was the earliest one to use scientists. A professor of the China Science and Technology University served as assistant governor of Anhui Province. He was connected to the scientific circles. He could go to Beijing to contact many scientists. Anhui Province also has a branch of the Academy of Sciences and a science and technology university. This mobilized many scientists to propose ideas for Anhui. The Anhui Provincial Committee invited a group of Beijing scientists to come to Anhui to survey the Shipihang irrigation area under Dabieshan. They also surveyed the northern part of Anhui and they proposed very good suggestions. Besides the central government and the province, there are also counties. Science and technology should also enter country government offices. Guyuan County under Liupanshan is a very poor place. The Chinese Academy of Sciences and the party committee of the Ningxia Autonomous Region cooperated and they wanted to help this county turn its economy around. The county committee invited a party member and deputy director of the Northwest Water and Soil Preservation Institute of the Chinese Academy of Sciences to serve as the deputy secretary of the county committee. This is a very good thing. The whole nation has more than 2,000 counties. Every factory has a chief engineer. Why can't the counties establish a chief agricultural engineer?

Comrades, in the Romance of the Three Kingdoms, the chapter on matching wits to establish the three kingdoms is very famous. Liu Bei visited the hut of Zhuge Liang three times and Zhuge Liang lectured Liu Bei. The speech became the strategic foundation of Liu Bei's endeavors to found a kingdom. I regard the intellectuals of present-day scientific knowledge (natural sciences and social sciences) as the collective Zhuge Liang of our Party and nation. They hold the knowledge of modern science and we want to use them. Modernization without modern science and technology will not work. Some comrades said, China's scientists had never held power and it is feared that they will not exercise power well. Not having held power does not matter, it can be learned. Also, among the experts, there are many who have scientific and technical knowledge and who have organizational talent. Of course, scientists also have their shortcomings. Modern science is finely divided and knowledge is specialized. But when you place him at a reasonable post, he can join more

scientists to draw up plans and policies. Also, he has the basic knowledge of science and he has received basic training in science. When he encounters a problem, he will not act contrary to the common sense of science. The popularization of a new technology and a new product will also be easily understood and supported. The new product will not go astray, it will not be refused and unaccepted. Is there any danger in employing scientists by the party administration at each level? I see no danger. After many years of political campaigns, especially during the 10 years of civil strife, many scientists and our cadres were criticized and struggled against, and all have become friends in hard times. Also, China's intellectuals have a good tradition which is the tradition of Lu Xun, Guo Moruo and Li Siguang, "willing to bow their heads to be servants"! Also, intellectuals are a part of the class of workers, and they are the forces which our party relies upon. Why can't we use them? Therefore, we must absorb some scientists to participate in party administration to lead production.

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RELATIONSHIP OF MACROSCOPIC, MICROSCOPIC RESEARCH PROJECTS DESCRIBED

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 1, Jan 82 pp 8-13

[Article by Wu Junqing [0702 0193 0165] of the General Rear Services Department of People's Liberation Army: "On the Systematic Structure and Systematic Balance of Macroscopic Scientific Research Projects"]

[Text] Macroscopic scientific research projects refer to research projects of the state, department or region, microscopic projects are research projects of an individual unit, professor or program. They represent respectively the whole and the components of scientific and technological research, they differ from each other and yet they are closely related.

Because China is a socialist country and because the organization of modern science and technology has entered an age of unified coordination and organization by the state; also due to the large-scale and the complex and integrated nature of science and technology, microscopic research projects should be integrated into macroscopic research projects in one way or another. The socialist system makes the fundamental interests of the two types of research projects in China consistent, but there are also some conflicts. Under normal circumstances and especially in today's readjustment period, "microscopic" should serve "macroscopic" and "macroscopic" should play a guiding role to "microscopic." The enhancement of macroscopic project study is therefore highly significant in making scientific research policy and is a major task before us.

A macroscopic research project is a structured artificial system consisting of many elements. When we study a macroscopic project we should first investigate what levels and elements are in the system and how the elements are connected and related and what is the quantitative relation between the elements which when combined form an organic system. We should also study the effect of this quantitative relationship on the overall efficiency and what relative ratio would optimize the system efficiency. Here the overall efficiency refers to the quantity and quality of research results and talent expended by the state, the department and the region which eventually will show up as an import on the economy and society and the degree to which a predetermined goal is achieved.

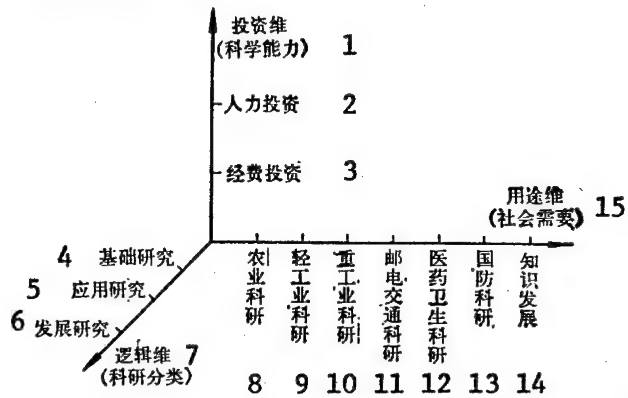
Using system theory we shall first analyze the system structure of macroscopic research projects in the space below. Then, based on the system structure, we propose the viewpoint of equilibrium in four systems; namely, equilibrium between research task and social need, equilibrium of the internal structure of scientific research, equilibrium of investment structure and the optimization of overall efficiency, as the basic requirements in formulating macroscopic research projects.

I. System Structure of Macroscopic Research Projects

To study the structure of a macroscopic research project we must dissect the system. Only in such a dissection can we recognize the component elements of the system and then proceed to study the correlation and relative ratio of these elements. After that, we can integrate, investigate and assess the overall effects of the system. The key question here is a proper dissection, without a proper dissection, scientific classification and correct understanding of the system will not be possible, not to mention neither will an in-depth study and overall optimization.

To begin dissecting a macroscopic research project, one should start with an analysis of the factors affecting the development of science and technology. Because the essence of studying a research project is to identify these factors accurately, formulating a research project amounts to understanding and treating the relationship among these factors properly. The development of science and technology is determined largely by three factors: the first one is society's need. Engels once said: "From the very beginning the generation and development of science is determined by production." Science and technology originate from production and social need, and end in production and social need. Society's need is a great driving force for science and technology development, and society's need is the mother of scientific invention. Research projects should therefore meet society's needs. The second factor is the internal structure and law of evolution of scientific and technological development. A definitive rule governs when a breakthrough occurs and in what field, when science transforms into technology and technology transforms into productive force, this rule is the internal logic of science and technology. Because in different countries and regions and in different periods of time the specific conditions and the degree of scientific and technological maturity are not the same, the probability of achieving research results is also different. Research projects should therefore match the evolution of science and technology. It should also be pointed out that the two above factors are related. Soviet scientists proposed a theory that social needs and science development meet at a point of intersection. Results and breakthroughs are most likely at this intersection point. It is therefore very important that research projects should not only satisfy society's need but also satisfy the need of scientific and technological development itself and the two needs should be reconciled. The third factor is the scientific ability of the society. Scientific ability is the ability of a nation, a region or a department to develop science and technology and it is also the material basis for scientific and technological progress. Undoubtedly, research projects should be compatible with the scientific ability.

Based on the analysis above, a macroscopic research project may be divided into three essential elements: social need, scientific classification and scientific ability, and each element can be further divided into various levels. These three elements constitute the three dimensions of the system structure, namely, the utility dimension, the logic dimension and the investment dimension, as shown in the figure below. We now discuss each dimension separately.



Key:

1. Investment dimension (scientific ability)
2. Manpower investment
3. Funding investment
4. Basic research
5. Applied research
6. Development research
7. Logic dimension (scientific classification)
8. Agricultural research
9. Light industry research
10. Heavy industry research
11. Telecommunication research
12. Medical and health research
13. Defense research
14. Knowledge development
15. Utility dimension (social needs)

1. Utility Dimension (Social Needs)

In the utility dimension, the utility classification of research is made based on social needs. We may use the industrial classification in the Chinese economic structure as a guide in making the division conducive to the implementation of the policy of science and technology serving the national economic and defense construction.

There are different divisions in industrial structure including the "two department division," the "three industry division" and the "agriculture, light and heavy industry division." The last method of division is more compatible with the current situation and actual needs of China. The utility classification can therefore include agriculture research, light industry research, heavy

industry research, telecommunication research, medicine and health research, defense research and knowledge development (without specific utility). Under these divisions, there could also be various levels; for example, in heavy industry research there could be metallurgical industry research, mechanical industry research, petroleum industry research, and so on. Defense research can be further divided into strategic weapons research, conventional weapons research and the latter can also be divided into aviation research, ship research, light weapons research, rear service equipment research and so on. Defense research can also be divided according to the armed services. On which level the divisions should be made depends on the scope of the research project; for instance, in a national research project the first level must be used (agriculture, light industry, heavy industry, telecommunication, medicine and health, defense and knowledge department).

2. Logic Dimension (Scientific Research Classification)

Science research is classified according to the internal logic of science and technology. A proper classification of scientific research helps to understand properly the status and role of various junctions along the road of scientific and technological development. By consciously following the law of development of science and technology, and making rational plans which take into account the overall situation, a normal order of research can be established. By making the organic connection of science--technology--production, science and technology can be transformed into a productive force as fast as possible. So far in China there has not been a unified method of classification for science research. Most people are inclined to divide it into basic research, applied research and development research. Any science or technology must go through these stages in its growth and development, this division reflects the development process of science and technology. Therefore, the logic dimension here is also the progress dimension, it not only represents the overall logic structure of science and technology but also shows how mature a certain science or technology is. Below the three major divisions, there again can be different levels. For example, for new product development in developmental research, there may be preliminary study, proposal study, full scale development (design, prototype, small batch production). Opinions on this division may vary and further study should be made.

3. Investment Dimension (Scientific Ability)

The basic components of scientific ability include the collective research ability of the scientific rank of scientists quality of experimental facility, efficiency of the library-information system, optimization of the labor structure in science, and the educational level of the nation as a whole. We do not intend to discuss scientific ability specifically; instead, we use the concept of scientific ability to study one element in the system structure of a macroscopic research project. Therefore, we have simplified and modified scientific ability and made it the investment dimension of a macroscopic research project. This dimension includes personnel investment and research fund investment, that is, we have condensed the material factors in scientific ability into the research fund. This dimension can also be further divided, science and technology personnel can be divided into senior,

intermediate and junior levels and research funds can be divided into capital construction fund, equipment fund and material fund, and so on.

II. Balance Between Science Research Task and Society's Need

The so-called balance between a research task and society's need means research efforts should meet social needs, it is also called utility structure balance. The content can be divided into two areas:

1. On the whole scientific and technological research should develop in coordination with the economy and society.

Economic and social development constantly put demands on science and technology and the progress of science and technology must satisfy the needs of economic and social development and promote economic and social progress. The role played by modern science and technology in the economy and society is no longer limited to the application of a single technological achievement, science and technology now have an important influence on a macroscopic scale on a nation's economic policy and development strategy. A number of issues are closely related to the development of science and technology, including the determination of a nation's goal in economic construction, economic structure reform, rational layout of productive force, sensible deployment of resources, technological improvements of enterprises, and the formulation of technological economic policy. But for a long time science and technology in China have been disjointed from economy and social development. Science and technology has not solved enough major problems in economic development and economic development has not relied enough on science and technology, each has made their own plans and projects and they are not connected. In order to have a coordinated development of science and technology, economy and society, the three must be treated as a trinity and given overall, balanced and coordinated consideration. Science research has a definite place in China's socialist construction and research funding investment should be a proper percentage of national gross product (or gross production value of industry and agriculture). In developed capitalistic countries, the national research investment is usually 2 ~ 3 percent of the gross national product. In Russia it is 3 percent (see Table 1 for details). In China there has not been a definite number regarding the research investment percentage of the gross production value of agriculture and industry, it is probably less than 1 percent. Obviously, science and technology in China is not at all compatible with the economic and social development. The Central Committee has decided to increase gradually the proportion of research investment during the national economic readjustment period, it is entirely necessary. As to what percentage is most appropriate, further study and assessment as to practice are needed.

Table 1. Research and development expenditure (1970-78) of various nations as a percentage of gross national product*

Year	France	West Germany	Japan	Britain	America	Russia
1970	1.91	2.18	1.79	--	2.64	3.23
1971	1.90	2.38	1.84	--	2.50	3.29
1972	1.86	2.33	1.85	2.06	2.43	3.58
1973	1.77	2.32	1.89	--	2.34	3.66
1974	1.81	2.26	1.95	--	2.32	3.64
1975	1.82	2.39	1.94	2.05	2.30	3.69
1976	1.78	2.28	1.94	--	2.27	3.55
1977	1.79	2.26	--	--	2.27	3.47
1978	--	2.28	--	--	2.25	--

2. Science research for different applications should be coordinated and balanced.

In planning the national macroscopic research projects, research in agriculture, light industry, heavy industry, telecommunication, medicine and health, and defense should be laid out rationally and properly proportioned in an overall structure. In planning departmental and regional macroscopic projects, the structure and layout of applications must be properly solved as well. The national economy stresses the policy of "agriculture, light industry and heavy industry" [in that order], so the first priority in science research should also be placed on agriculture, followed by light industries that are labor intensive, require modest investment and have a pronounced effect. This is an important task in our current readjustment. There should be a proper proportion of the investments made on various applied research and this proportion is yet to be studied and tested. In foreign nations, their investments on the various applied areas are shown in Table 2.

*From "Data Compilation of Foreign Science and Technology Management," p 60.

Table 2. Percentage distribution of R and D expenditure according to mission in various countries*

Country	Year	Defense	Space	Energy	Economic Develop-ment	Medicine and Health	Social Social Services	Knowledge Develop-ment
France	1967	35	6	20	16	1	1	20
	1976	30	5	9	23	4	2	26
Japan	1965–1966	3	0.5	3	27	2	2	63
	1974–1975	2	5	8	23	3	3	55
Britain	1966–1967	52	4	13	14	3	0.5	12
	1975–1976	46	2	7	20	3	2	20
America	1966–1967	49	32	5	5	6	2	2
	1976–1977	51	13	9	9	10	5	4
West Germany	1971	15	6	16	13	3	2	41
	1976	12	5	11	13	3	5	51

III. Internal Structure Equilibrium of Science Research

Internal structure equilibrium of science research, also known as logic structure equilibrium, refers to the coordination and balance of different researches on the logic dimension of the macroscopic research system. For research projects on the national level, an appropriate and stable proportion should be maintained between basic research, applied research and development research on the basis of the internal rule of science and technology. For regional and departmental projects, such as a department engaged mainly in product development, there should be aproper balance of the four stages of preliminary research, proposal study, full-scale development (design and prototype) and small batch test production. For basic research, because it does not have clear-cut stages and its management is relatively reflexible, its balance on the logic dimension may be taken as the proportional equilibrium between various disciplines and the organic internal connection between the disciplines is manifested in such an equilibrium.

*From "Data Compilation of Foreign Science and Technology Management," pp 62-63. (Except the United States, all other countries include general expenses for universities in the knowledge development category.)

When a nation, a region or a department manages the various sectors of the research project on the logic dimension, it involves a coordinated and overall arrangement of the short, intermediate- and long-term science research. Science and technology itself is a knowledge system for understanding and improving nature, therefore a research project must be a dynamic development process and there must be a certain continuity and derivation. There should not only be science research for solving immediate economic and social problems, there should also be medium-term and long-term research to suit the future development needs of the society and the economy. A complete and well coordinated system of research should be formed so that the enterprise of science and technology may progress continuously and systematically with foresight and without interruption. If the science and technology development of a nation, a region or a department does not have foresignt and reserve and is not prepared for anticipated events, then its vigor and life will be very limited.

Proper arrangement of various types of research and rational structural layout of the projects have a profound effect on the development of a nation's industry, agriculture, science and technology and defense. From the historical experience of some nations, generally speaking developing nations in the early stage of modernization should place their emphasis on applied research and development research. In the meantime, attention should be given to basic research as well and, along with the improvement of the economic base, basic research should be increased in proper proportion in order to promote the development of applied research. Bias against any one area would lead to adverse results. In Japan, for example, emphasis was placed on applied research and development research in the early stage of recovery after the war, and its economy developed rapidly, but in the late 1950's when its basic research should have been strengthened and was not given proper attention, it affected the smooth development of applied research to a certain extent. The Soviet Union has traditionally put 95 percent of its scientists on basic research and neglected applied research and development research, it was therefore in an inferior position in some technologies. In the mid-1960's they realized their situation and paid attention to changing it. China is in the early stage of its modernization construction, the emphasis should no doubt be placed on applied research and development research. The weak link of development research should especially be strengthened. In the meantime, basic research should also be allotted a proper proportion of emphasis and allowed to develop steadily (expenditure on basic research in China today is approximately 5 percent of the total science research expenditure). The ratio of applied research, development research and basic research should be determined on the basis of our resources, economy, technological force and needs in social and economic development. But the prerequisite and today's urgent task is first to have a clear understanding of our present ratio of the three sectors.

In order to learn from foreign experience, we have listed below the investment percentage on various researches in other countries.

Table 3. Investment percentage on various researches in other countries*

Country	Basic Research	Applied Research	Development Research
Russia	12.9	60.5	26.6
America	14	22	64
Japan	11	31	58
West Germany	12	24	64
Britain	12.5	26.1	61.4
France	17.5	33.9	48.8

IV. Investment Structure Equilibrium

The term investment here includes mainly two areas: research expense investment and scientific and technological personnel investment (manpower investment for short, same in below). The balances discussed above between the research mission and the social need and within the internal structure of science research must both be realized through the balances in expense and manpower investments, and investment balance is their quantitative representation. Through expense investment and manpower investment, macroscopic research planning is an implementation of effective control and management of the research mission based on the utility classification (representing the effects of science research on the economy and the society) and the internal logic classification (representing the progress and maturity of science research). It should further be explained that investment balance is in essence the macroscopic balance of research mission and research condition, i.e., giving the research mission proportional manpower and expenditure investment according to the weight and urgency displayed on the utility dimension and the logic dimension. The balance between the research assignment and the research condition has traditionally been the weak link in science research planning. In the past, planning was often just adding the topics together and assignment and condition were not balanced (this depends on the management system). But this balance happens to be an important condition for a smooth development of the enterprise of science and technology.

In addition, investment structure balance has two more implications, one is the mutual balance between expenditure and manpower investment and the other is the internal structure balance of each. The mutual balance refers to the coordination and equilibrium between personnel growth and expense growth

*From "Personnel and Expenditure Data of Russian Research Organizations" (Note: The division of development research is different in Russia and in America.)

(including additions of equipments). For a given research, the average amount of expense needed per annum by each researcher is usually some reasonable number. If manpower and expenditure are not balanced and anomalous development takes place then the scientific ability cannot be complete and waste will occur.

The internal structure balance of research expenditure refers to the proper proportion of various expenditures, including capital construction expenditure, equipment and apparatus purchasing expense, material and supply expense, library and information expenditure and expenses for collaboration. If these expenses are not in proper proportion, science research will suffer.

The internal structure balance of research personnel refers to the rational structure of various technological personnel. The numbers of senior, intermediate and junior researchers are usually in that order and show a pagoda-type structure. The ideal ratio of the number of doctors, doctoral candidates and nondegree personnel among researchers in Soviet colleges and universities is believed to be 1 : 3 : 16. There should also be a proper ratio of researchers, technical staff, support staff and research management personnel and this ratio varies for different types of research.

V. Optimization of the Overall Effect

We take the view that macroscopic research planning is a system and this system is like a precision machine. Manpower and expenditure investments are inputs in the system and research results and talent growth and the effect on the economy and society (collectively known as research results) are the outputs from the system. The project itself is the system's command and the function of the project is to adjust continuously the structure and proportion of the system, maintain relative balance in the system and keep the ratio of input and output in an optimum conditions (input-output equilibrium) and make the output satisfy the goals of the project, that is to say, optimize the overall effect of the research planning system. The rationality of the structure and layout of a macroscopic research planning system is appraised collectively by the overall effect. Therefore, the optimization of overall effect under discussion here is also the general equilibrium of the system.

The appraisal of the results of research investment is an complex question. This question should be a research topic and cannot be discussed in detail here. It suffices to point out that an overall direct or indirect evaluation of the research result is possible. We may use foreign experience as a reference in gradually establishing our own system for evaluating scientific research results. Today some countries use the following items as output (production) indicators of the science and technology system: the quantity of science literature, the quality and influence of science literature--the citation ratio, the number of international science award winners, major technological invention and innovation, patent differential (that is, the difference between the number of foreign patents obtained by the nationals of a country and the number of patents granted to foreign nationals; if the former is greater than the latter, it shows that this country is doing well in science and technology), technical patent exchange (i.e., the surplus or deficit in international patent

exchange, a surplus means good achievements in science and technology), labor production rate and foreign trade difference. Using these indicators to evaluate the scientific and technological enterprise in major nations, one finds that the United States is basically still in the lead. For example, from 1946 to 1979, there were 192 Nobel Prize winners in science, and of these the United States had 98 or 51 percent. An international specialist group selected 492 major technological innovations from 1,310 items in the 1953-73 period and of these the United States had 319 or 64.8 percent. America has always maintained a surplus in international technical patent exchanges. Its 1977 income was 4.725 billion dollars, expenditures were 447 million dollars and there was a surplus of 4.278 billion dollars. In the past 20 years the U.S. labor productivity rate has always been higher than that of other scientifically advanced nations like France, West Germany, Japan, Britain and Canada. In 1977, for example, if we take the average U.S. labor productivity value as 100, then France was 84.7, West Germany was 79.1, Japan was 62.2, Britain was 55.1 and Canada was 91.6. Of course, the United States has made relatively large investments in science and technology, the absolute value of its research and development expenditure is among the highest in the world and its manpower investment is next only to the Soviet Union.

Based on the specific situation in China, we must strengthen our study of macroscopic science research planning, unify the classification of science research, perfect our planning and accounting system, consolidate historical experience and, based on the needs of the four modernizations construction, establish a national, regional and departmental macroscopic research planning system, rationalize its structure, maintain its equilibrium and optimize the results. At this time it would be difficult to make quantitative comparisons of our research results with that of other countries. We could however compare our present to our past and the future of the present and achieve a reasonable proportion in these comparisons and find a path that is suitable for China.

FOOTNOTES

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9698
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SCIENTIFIC, SOCIAL ROLE PLAYED BY VARIOUS SCHOOLS OF THOUGHT

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 1, Jan 82 pp 14-19

[Article* by Lu Taihong [4151 3141 1347] of the Jiangxi Institute of Science and Technology Information and Liu Dachun [0491 1129 2797] of the China People's University]

[Excerpts] Introduction

In Cohen's language, science development is realized in the succession of different "standards." A standard is chosen by a group of scientists and at the same time it determines the basic viewpoint and method of study of this group of scientists.

This group of scientists in a broader sense is also a school of thought. Science history shows that free competition between schools of thought leads to a continuous succession of old and new theories and is an important factor in science development. We often say that let all schools of thought compete. These are statements of the same principle in different words, because the entire history points to this principle of science development.

Schools of thought play a dual role in science and in society, they are not only a unique structure in science development but are also the products of certain social factors and the results of a mutual relationship between science and society. Schools of thought and the competition among them reveal an important aspect of science and society relationship. Science is a social activity, this is quite different from the superficial impression it often gives people. People often have the impression that science is the product of the individual activity of scientists and science appears to be purely in the realm of individual free thinking. This view does not reflect the true nature of science activity. Scientific activity is organized socially and schools of thought are simply a special form of socially organized science activity.

*This article discusses only schools of thought in natural sciences.

Since the question about schools of thought is so important, an in-depth understanding of the characteristics of schools of thought and their role will be very helpful in handling the laws of science development. A complete understanding of the schools of thought can only be reached by understanding their characteristics and functions and this understanding can then benefit the overall implementation of the policy of letting all schools of thought compete, and the management of science and technology.

The "let a hundred flowers bloom and let a hundred schools of thought contend" slogan put forth by Chairman Mao correctly pointed out that we must develop different schools of thought in order to advance China's science. We firmly believe that schools of thought have a major role in science and society and in the managment of science research we should begin with external factors to assist schools of thought and encourage competition.

First we must respect science autonomy. The first questions encountered in research management are whether to recognize the independence of science and whether academic problems should be settled within science or solved by external decision. Looking back in science history we must admit that science is a system with a certain self-regulating power and is a social state with a certain degree of autonomy. Even though science has been persecuted by religion and theology, bound by autocracy and superstition, eroded by idealism and metaphysics, as a whole science never "died" and on the contrary science has become more and more powerful. This indicates that science has an internal vitality and a certain regulating function. Just as the human body is a self-regulating system that may become maladjusted and confused under excessive external stimuli excessive interference in the science system can only bring about disruption of the internal order of science and cause the function of science to deteriorate, perhaps even giving academic fraud some opportunities for exploitation. In the Soviet Union, the Lysenko experience of the 1930's dragged on for decades, in 1940's the "new cell theory" was advocated, in 1950's it was proposed to "reform medicine with Pavlov's theory" and nullify Wei-er-he [phonetic] cell pathology, and in the controversy between the Michurin school and the Morgan school, the latter was condemned as "pseudo-science." The direct results of all these incidents is that academic frauds became the despots of the science profession and different schools of thought were persecuted as political opposition factions. These are the reasons that Soviet agriculture has long followed a tortured path and Soviet genetics lagged behind the West by several decades.'

Next, substitutionism and simple determinism should be avoided in the academic appraisal of schools of thought. Science history shows that a school of thought or an academic viewpoint does not have a simple one-to-one correspondence relationship with social status such as politics, philosophy, nation, region or faith. In other words, various ideologies of the society have a crisscrossed and multidimensional effect on the formation of academic schools of thought. This is why substitutionism or simple determinism will never work in evaluating the correctness of various schools of thought. In the Soviet Union the only recognized celestial evolution theory is the "Russian-made" capture theory of Schmidt and it is considered the real "dialectic materialism." All the other theories such as the galaxy theory or the mutation theory

are all "bad theories." But in the end the showy "capture theory" faded from the science arena and became a historical lesson. As to Hitler's "Jewish physics" theory, history has scoffed at it without mercy.

In a deeper sense, the internal bases for the existence of a school of thought are the different assumptions and standards with which the scientists try to understand the world. They are often based on different scientific beliefs, viewpoints and methods and there is a certain degree of incompatability between them. For example, in 19th century physics the school of particle theory of light led by Newton and the school of wave theory of light led by Huygens each insisted on their view and fought for several decades. It would have been impossible to make a judgment call at that time. In China there once was criticism against Prof. Wu Rukang [0702 3067 1660] on the question of the origin of man, in geology there was criticism against Prof. Chen Guoda [7115 0748 6671]. Resonance theory, control theory, information theory and quantum theory have all been criticized, but all these criticisms did not survive the test of time.

Finally we should be careful to avoid and overcome the residual feudalism in academics. Schools of thought and their competition are a high form of academic freedom. Various feudalistic consciousnesses are only internal obstacles and threats. In order to realize the socialist four modernizations, Chinese academia has a duty to counter feudalism just like the other professions.

In order to foster different schools of thought, academic superstition must be avoided. There are plenty of historical examples of those in power repressing the common people and authority making the wrong decision. Academic leadership should therefore avoid relying on direction by individual academic authority, and innovative academic viewpoints should be encouraged and protected in scientific publications and society activities. Similarly, science frauds are not infrequent in the history of science. In order to preserve a health competition among academic schools, we should especially maintain the dignity of research results, pay attention to talent recognition, promote science ehtics, and prevent faction activity. Einstein and the leader of the Copenhagen school, Niels Bohr, competed over a period of 30 years but they have always maintained an intimate friendship. This is a good example of respecting science ethics.

Today in China the climate for schools of thought formation in the development of science is gradually maturing. A new generation of successful scientists, influential academic centers and different schools of thought will gradually appear. Science research management should anticipate this situation and take advantage of it and give them assistance. One should not throw out the baby with the bath water or give up food for fear of choking. In the bigger picture, competition among schools of thought is one of the driving forces in science development and from the point of view of goals, letting a hundred schools of thought contend is necessary precisely for the purpose of reducing the pitfalls of academics to a minimum degree. A truly prosperous situation of a hundred schools of thought is a vivid realization of the high degree of democracy and civilization of socialism, let us all strive for it.

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POLICY REGARDING MISSION OF RESEARCH INSTITUTES DISCUSSED

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 1, Jan 82
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[Article by Gu Jiugang [7357 0046 4854] of Shanghai Institute of Laser Technology: "Policy Study and Practice of the Mission of Research Institutes"]

[Text] The primary issue in establishing a research institute is to specify the guiding thought and determine the direction and mission of the research institute. Whether the policy regarding this question is correct affects the future of the institute directly and it is also an important sign of the decision ability and leadership art of the institute's leaders.

In the past few years, under the spiritual encouragement of the national science conference and the guidance of the party policy, the Shanghai Institute of Laser Technology conducted some policy studies regarding important issues that affect our institute for the sake of developing laser technology. We have obtained some preliminary results in this practice and consolidated some experience.

Part 1

I. Defining the Problem

Because of the interference and disruption by the "gang of four" extreme leftist lines during the 10 year turmoil, the Shanghai Institute of Laser Technology was turned into something which was neither a plant nor an office nor a school nor a research institute. it had neither a specific research direction nor fixed research fields. For a long period of time, projects were in confusion, management was backward and there were more people than jobs. After the fall of the "gang of four", our institute faced the serious question of where to go and how to continue. The proverb has it: "When decisions are not made as they should be the indecision itself becomes a problem." Therefore, an important policy decision for readjustment, consolidation and insuring the healthy development of research at the institute and mobilizing the initiative of all the technical personnel is to formulate a correct and practical research direction and mission as quickly as possible.

II. Investigate and Analyze the Current Status

In formulating the direction and mission of a research institute, one usually studies the following problems: (1) The actual situation of the field and technical development in China and in Shanghai and demands to the field by the national economy; (2) Foreign activity and experience in this field or technical development; (3) The nature, special features and laws of development of the field or technology; and (4) Research structure, potential and advantages of the institute in question. A correct and practical policy proposal can be formulated only after a thorough investigation and analysis of the current situation in terms of the questions listed above.

Laser technology is a new technology developed in the 1960's. After 20 years it has acquired useful results and proliferated widely. It has promoted the advancement of other science and technology. Today there are more than 30 countries which have laser manufacture organizations. In the past few years investment in laser research, volume of sales and number of researchers engaged in laser investigation have steadily increased.

China has a relatively early start on laser technology and developed its first laser in 1961. There are now 21 laser research institutes in the nation. Laser research in Shanghai began in 1963 and now there are 180 units engaged in technical research, production and application of lasers and a result of almost 100 research achievements. Commercial units of the common laser and its element and material are now available and statistics show that the gross value of production in 1979 and 1980 have exceeded 7 million yuan. Lasers are broadly used in industry, agriculture and medicine.

Lasers have been in existence only 20 years but the enormous accomplishments generated by their production indicated a strong vitality and a bright future for application; this is unusual in the history of science and technology. Hence it is highly significant that China has made laser technology a high priority new technology for development. However, because of the interference and disruption of the Lin Biao "gang of four" extreme leftists, plus problems in our own work, the development of the laser industry was affected. The major problems in the current laser work are chaotic management system, lack of unified planning, each system going its own way, no clearcut division of work among the units, everybody jumping on the hot topics while no one is working on topics that are particularly necessary and in short supply and large amount of low quality duplication. Products that can be offered are very few in number.

The Shanghai Institute of Laser Technology was established in 1970 and since that time, even though the institute suffered serious intervention and disruption by the "gang of four," we have made a great effort in the past few years and obtained some research results. Relatively good accomplishments have been made on the promotion of laser application and a preliminary professional research team of high quality and vigorous young researchers has taken form. We now have more than 200 technical staff and more than 100 technical workers. At the same time we are in possession of facilities for basic science experiments and integrated experimental shops equipment with light, mechanical

and electrical systems and the institute has laid down the technical and material foundation for future development.

After this investigation and analysis, the basic situation is understood. In terms of basic research, although we have a certain ability to conduct applied basic technology research, we do not compare favorably against research institutes of the Chinese Academy of Sciences and universities and colleges. In terms of batch production, although we are somewhat more adaptable, we are still inferior to professional plants. But in the area of basic technology and applied research, we have certain advantages in adaptable and coordinated technology and our ability is beyond that of an ordinary local research institute. In terms of test production ability, we are also superior to other comparable institutes or specialized plants in China.

III. Determine Goals and Formulate Plans

Under these circumstances, we listened to the opinions of superior administrative departments and associated specialists and after repeated analysis, screening and consolidation, we have finally determined that the Shanghai Institute of Laser Technology should be a specialized research institute devoted to the technical research and development research of laser application. With several years of effort, our institute should develop into a unique specialty research institute in China that has a relatively high standard of research and technology and can provide both small batch advanced laser products and a broad range of technology application. The long-term goal of development is to gradually form a combination of research, development, production, sales and service and make more contributions to China's development of laser technology and national economy. The specific plan is to emphasize applicability and economic effect in research and, concurrent to research, strengthen our ability to test production and technical service to satisfy the needs in the popularization of laser technology applications. Centered on the primary mission of serving the national economy, we should organize an effort to produce small batches of laser products (including the laser, elements and the whole system) and the associated parts and actively develop the sales and technical service of laser products.

Part 2

To a research institute the determination of its direction and mission is equivalent to a strategic decision. To carry out this strategic policy and proposal, however, one must make many tactical decisions and specific plans.

I. The "Five-Fixes" Policy and Its Implementation

At the end of 1978, after the direction and mission of the institute were determined, we further proposed new tactical decisions. An institute-wide consolidation centered on research and consisting of the "five-fixes" was initiated. This was an important measure politically to eradicate from the research field the extreme leftist epidemic, it was also an important step to consolidate and readjust the organization, it was even more of an important

insurance for promoting research production, and talent and result output to satisfy long-term development.

The "five-fixes" refers to fixed direction and assignment, fixed topics, fixed conditions, fixed system and fixed personnel. It is a difficult task but without the "five-fixes" the institute's strategic policy cannot be accomplished. If the research assignment were not fixed, all the researchers would be doing nothing; if the equipments were not fixed, there would be unscrupulous waste; if the regulations were not fixed, it would be impossible to do things according to the laws of science and economics; if personnel were not fixed, there would be more people than jobs and "eating out of the big pot" and there would be researchers improperly assigned and unable to develop their talent. It is difficult to fix the assignment but it is even more difficult to fix personnel. The difficulties are that there are too many ideological problems and too large a workload and the decision is mostly a policy matter. However, "a rolling stone collects no moss," we can overcome the pitfall of "not learning what one would be practicing and not practicing what one had learned" only by circulating the personnel in the framework of fixed personnel. This was a key tactic policy of our institute.

In carrying out the "five fixes" policy, to both the researchers we kept and we let go, the principle of "letting everyone develop his talent and making full use of the talent" was adhered to. The spirit of unified arrangement and full responsibility was firmly upheld. If a person could play a role by remaining in the institute, he would be kept whenever possible; if a person could not play a role in the institute, then he would be transferred to a more appropriate place whenever possible. Every effort was made to make the outgoing people happy and the remaining people feel secure. Through the "five fixes," more than 50 comrades were transferred out of our institute to new posts, in most cases the arrangements were properly made and these people were able to function relatively well in positions matching their specialty. At the same time we have also conducted technical evaluation on all technical personnel and promoted 61 research assistants and engineers. In addition, some core researchers were transferred in from other units to strengthen our ranks. After the "five fixes," our technical staff became a refined, vigorous young team of quality that had a faster growth and put the various tasks of the institutes on the right track. The "five fixes" was the successful first step in realizing the strategic goal of our institute.

II. Regarding the policy of "expanded research institute autonomy test point" and its implementation

As research and production continued to develop in 1979, we fought our second battle, namely, carrying out the policy of expanded autonomy test point. The objectives of this policy were to manage research production by economic means so that research and the national economic construction could be tightly joined and to promote a faster development of research by means of the favorable conditions of an expanded human rights and financial rights so that the research-development-production-sales-service complex could be formed. Expanded autonomy was something that has never happened in our institute; if the decisions

were not made in a bold and yet prudent fashion, then the expected results could not have been obtained. Hence the entire process must be carried out meticulously. We designed the policy and implementation steps carefully. The procedures consisted of mainly the following steps: (1) Based on the questions raised, collect information and analyze the situation; (2) On a predictive basis, clearly define the goals and specify the requirements; (3) Design a few implementation plans for the expanded autonomy test point; (4) Assembly various representatives, especially experts from academic committees, to evaluate and compare several proposals and select the optimum proposal by weighing the pros and cons; (5) Conduct local experimental verification of the selected plan to observe the results and use it as a feedback to the decisionmaking; and (6) After the success of the local test point has verified the practicality of the policy, strengthen the feedback and make necessary corrections before putting it to general implementation.

These necessary steps put the policy through the repeated tests of predictive discussion, comparison, argument and actual verification. Since we started our autonomy expansion test points, because the decisionmaking process directly reflected the objective logic and rules of the policy, encouraging results have been obtained in the past 3 years. From this experience we have realized the following advantages of expanding the institute's autonomy: (1) It promoted the coordination between research and production and promoted the economic effect in science research. The source of research assignments in the past came largely from literature search, since it was often removed from actual application, the efficiency has been poor. Now that more attention is placed on actual technological problems in production, and research contracts are actively sought after, more contributions will be made toward economic development. For example, the successful development of six equipment items (holographic photoelastometer, holographic titration spectrograph, laser velocimeter, helium-neon laser, CO_2 laser and laser modulator) was scheduled from the very beginning according to actual needs or research contract. Because research and application were closely coordinated and goals were clearly specified, good economic results were obtained and the accomplishments played a role in the national economy and scientific research. The technical specification and performance of some of these products have reached the advanced level in China, some of them have filled a void in China and some have approached the advanced international standard. These items have been an important financial source of income to our institute during the past several years. The research income and product income of three items alone--holographic titration spectrograph, photoelastometer and high power helium-neon laser--have reached 1 million yuan. (2) It promoted the commercialization of research products. Many researchers have changed their original attitude of noninvolvement and worked hard to turn sample and display specimens into products and commodities. For example, the He-Ne laser group and the CO_2 laser group kept improving the power and lifetime of the devices and designed and test-produced serialized products based on different needs of the customer. This has not only increased the competition in power among similar products but also contributed to the promotion and application of laser technology. In the meantime, research was conducted according to laws of economics, research results were transferred with compensation, both the buyer and the seller assumed economic responsibility and the direct transformation from

research results to productive force was expedited. (3) It prevented blind initiation of new projects by selectively supporting the meritorious projects with economic backing. Selective support of the meritorious projects comes from economic management. Together with an improved ability to compete it makes us more prudent in initiating new topics and prevents the danger of being washed up in the selection due to low quality and repetitious research. Applied research should be made relevant whenever possible. Moreover, the economic accounting of the projects has made the entire research operation calculated more carefully in spending manpower, material and funds. (4) It helped to mobilize the initiative and improve the efficiency of research. After the promotion of the research contract system in the test run of expansion of the autonomy of research institutes, economic effect and economic responsibility have been improved and attention was given to the interests of the state, the unit and the individual simultaneously. In the last 2 years, our institute has finished more than 90 percent of the research projects. Thirteen research achievements were obtained in 1979 alone and 8 out of those received major research awards of Shanghai Municipality in 1979. In 1980, nine more achievements were accomplished, In terms of income, the institute had more than 500,000 yuan of income in 1979, or 1.8 times greater than that of 1978. In 1980 the income has doubled again and increased to 1.13 million yuan. The institute has not only contributed to the state but also further increased the development fund for research production and at the same time increased the funds for group benefit and staff award and motivated the socialist activeness of the staff and workers. (5) It advanced the improvement of research management. By conducting economic management, the research assignment takes on a clear awareness of economics and time. Various leaders and managers have also further improved the responsibility system. Prompted by the test point effort, we have established and perfected a management system since 1979, revised the limits of functions and responsibilities of various departments and the responsibility system of individual posts, gradually reduced the ranks of nontechnical and nonproduction workers and correspondingly increased our management quality and work efficiency.

Working toward the strategic goal set by the institute for the last 3 years, we have carried out a series of specific decisions and put them into action and greatly promoted the development of our institute. "Practice is the only standard for testing the truth," the practice of a policy decision is a test of the policy itself. Facts have shown that our overall policy and specific decisions are correct and productive.

Part 3

In the process of policy study and implementation, we have realized keenly that the success of a policy really depends on the following three factors: information processing system, quality of the decision maker or the decision-making group and a capable advisory team.

I. A Complete and Accurate Information Signal Processing System

The strength of the decisionmaking ability to a large degree depends on scientific method and the complete and accurate acquisition, analysis and

integration of large quantities of information and feedback signals. The process of decisionmaking is in fact a process of analyzing, screening, and processing this large amount of signal. In the determination of the mission direction of our institute, for example, it would have been impossible to determine the goal and formulate the plan without conducting extensive investigations and collecting large amounts of data. The collection and processing of signals are therefore necessary prerequisites of decisionmaking. Our approaches in establishing and utilizing an information system are as follows: (1) Based on work requirements, make the necessary organization healthy. Except for organizations of ordinary function and basic offices, we have, based on the needs, channeled all the problems on research direction and assignment and various academic problems to the institute's academic committee or office for study and action. All problems regarding research policy and economic management were directed to the autonomy expansion test point group for study and action. Routine study of the literature and the collection of research news were handled by the information data office and the information was processed periodically in the form of journals and briefings. (2) In order to improve the accuracy and utilization rate of the information, the system should not only extend vertically but also horizontally. In practice we gradually established a system of three meetings, namely, the institute director business meeting, the party affairs meeting and the institute-wide research production coordination meeting, and formed a crisscrossed information network system. (3) We used different methods and channels to follow information outside the institute. We tried to produce information sources whenever possible by relying on the routine activities of all the institute personnel including on-leave research, academic exchange, technical appraisal and business trips. As the saying goes, one should "look in six directions and listen from eight corners."

Thus, in actual practice a continuous flow of information will be transmitted rapidly, accurately, and directly through the system and network to the advisory board of the decisionmakers and provide reliable information for the leadership to make correct decisions.

II. A High Quality Leadership Group

The leadership or leadership group is not only the policy maker but also the implementer; their quality and leadership technique are often the key to the success of the policy. The formation and generation of a policy does not just happen on its own and is not based on the subjective speculation of an individual. Instead, it is a complex process of repeated analysis, reasoning and judgment that involves a great amount of information. The individual or group of individuals completing this process must be of high quality and leading ability. Unqualified or incompetent leaders and shoddy leadership may lead to wrong decisions which can jeopardize a unit or even undermine our entire cause. We believe that a decision maker must have the following qualifications: (1) He must have a strong sense of duty and a strong desire to achieve. This is a prerequisite to decisionmaking ability. A leader without a grand design in his mind will invariably be occupying the position without doing the job and he would delay, procrastinate, or shift responsibility and timely, firm and correct decisions could never be made. A leader can acquire the skill and art of leading by being enterprising, aggressive and by studying

hard and thinking more. (2) A decision maker should have a keen and unique ability to comprehend and observe. Research units often have to deal with many new problems and the leader must make many unconventional decisions. The leader must therefore never stop learning new knowledge and must continuously consolidate experience of his own and others. One can remain in an unbeatable position only by making timely policy revisions according to the development of the situation. (3) A decision maker must be good at independent thinking. Everyone has his own way of independent thinking. It gives the decision maker a correct understanding of the situation and prevents him from being swayed by a one-sided view or opinion of the majority. He can then weigh the merits of different opinions and come up with the right decision. Many new discoveries and new topics are frequently unexpected, the decision maker must timely and flexibly change a part or most of the established plan so that a good opportunity will not be missed. Independent thinking can often broaden the scope of observation of a decision maker and allow him to consider plans strategically. It can therefore improve the quality of decision making and make it more creative while at the same time improve the leadership quality. (4) A decision maker must be good at using favorable factors and know how to assign jobs. The work after the decision is very important, the selection of a decision is only the beginning of decisionmaking and the key to success is the implementation of the decision by the entire staff. A decision maker should therefore make every effort to have his decision acceptable to the public and broadly mobilize the initiativeness of everyone to implement the policy.

III. A Capable Advisory Board

The knowledge and ability of a leader or a leadership group are limited. In making major decisions, the participation of advisors and think tanks are needed to make the decisions correct and more effective. The advisory team mainly consists of members of the academic committee who have business specialties and members of the autonomy expansion test point organization who are knowledgable in policy. In addition, a decision maker should also solicit the opinion of some technical staff who are not on the advisory team but are ideologically active. This is an important aspect of following the mass line and respecting the experts. We should always watch out for the pitfall in which the ones with the decision powers do not know science and the ones knowledgable in science do not have the decision powers. If we can prevent that from happening, then the close tie between leadership and experts can be insured.

The art of decisionmaking is very multifaceted and it changes with the situation. One can manage the new leadership art of decisionmaking only by constantly studying the theory and summarizing the work.

Over the last 3 years, the leadership of our institute has made some preliminary progress on improving the decisionmaking ability. Through constant learning, practicing and exploring, we have further realized that, although there are many different ways to improve the leader's ability and technique of decisionmaking, the most fundamental principle is to stick with the basic view

of materialism dialectics and to insist on doing things according to the laws of science. If we make full use of the various ways and means of science and consciously guide the decisionmaking with them, then we can always formulate correct policies. Victorious generals on the battlefield are often described as achieving a victory while thousands of miles away by planning and operating, this is because the art of decisionmaking was first used in the military. Today the study of scientific decisionmaking has received the wide attention of leaders and many victorious generals in science research will no doubt come on the scene as scientific research continues to develop.

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MANAGEMENT OF ENGINEERING RESEARCH SUBJECTS DESCRIBED

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[Article by Lu Naiqian [4151 6621 6197], Xing Zhenyi [6717 3791 5030] and Wu Pingsen [0702 1627 2773] of the Shenyang Branch of the Chinese Academy of Sciences: "Characteristics of Engineering Research Projects and Their Management"]

[Text] The subjects of scientific research can generally be divided into basic research, applied research, and development research. Engineering research subjects of a research institute are usually large-scale and comprehensive research projects. They are often urgent defense and military subjects or major subjects in the national economy such as research on astronomy satellite and resource satellite. These comprehensive researches are generally interdisciplinary in nature, they not only involve the research of new material, new technology and new method and the fabrication of new components, they also involve theoretical studies of an applied nature.

The essence of management is an effective control of the management object based on its characteristics and regularity. The management of scientific and technological research must also be conducted according to characteristics of the subjects.

In the development of science and technology since the 1940's, foreign countries have acquired successful experience from major engineering research such as the "Manhattan project" in which the United States developed the first atomic bomb and the "Apollo project" of sending a man to the moon and the "project evaluation technique" used in the research and development of the Polaris nuclear submarine. In the meantime, computers have been used in foreign management projects. Foreign experience may serve as our reference and inspiration but because of the objective material limitation and the difference in national situation, we could not, and should not, simply copy their experience. We must study management problems of a different nature on the basis of our scientific situation. In this article we summarize our experience and discuss the characteristics and management of engineering research subjects.

Characteristics of Engineering Research Subjects

(1) The comprehensive nature

Engineering research subjects of a research institute are usually multidisciplinary and multiprofessional comprehensive research topics. Examples are artificial satellite heat shield and high temperature antenna worked on by a certain institute. The institute not only had to solve problems of metallic material but also had to develop and fabricate components and provide a test piece or the first quantity of real objects. This involves a series of technological problems (such as welding, forming, machining and heat treatment) and technical problems (such as inspection, analysis and testing). Not only must each technology and technique withstand the challenge of application conditions, more importantly, each technique and technology must also be closely matched with the material and the designed use so that all aspects are in coordination and compatible and a comprehensive ability to solve engineering research problems can be formed. In order to solve the problems listed above, it is often necessary to solve some related problems simultaneously such as cause analysis, damage mechanism and other application theory problems. This has given the management of engineering research topics some distinctly different characteristics and more complex factors than the management of other subjects.

(2) The systematic nature

In general, engineering research subjects not only include research and trial manufacture but also design and application. The scope of engineering research is broad, the work is heavy and the factors affecting engineering research are complex. Thus, research-trial-manufacture-expanded experimentation form a system and design-research-application form another system and engineering research subjects are themselves an organic system. The management of engineering research subjects is therefore the management of a complex system.

(3) The mission-oriented nature

Topics in engineering research are usually urgent tasks required by the state or the departments and they differ from the ordinary exploratory research. They have a specific timetable and technical requirement and are usually required to provide finished products to the user. Major engineering research projects are required to be not only of high quality but also "fail-safe." Hence this type of research has a distinct mission-oriented character and, in terms of management, one must consider not only its research nature but also its mission-oriented nature.

The integrated nature, systematic nature and mission-oriented nature of engineering research topics dictate the management to be characteristic of ordinary science research management and have some character of engineering management. This management must be organized to the integrated, systematic, and mission-oriented nature of engineering subjects.

Management According to the Characteristics of Engineering Research Subjects

(1) Choosing project leaders according to the nature of the subject

Engineering research subjects form a complex three-dimensional dynamic system. The management of an engineering research topic is essentially the management of a system. The most important job is to choose the right people to lead the system and the subsystems. Just being an expert is not qualification enough to be a project leader, a comprehensive ability is required as well. In our experience in engineering research, leaders of a topic (system) or subtopics (subsystems) should have the following qualifications: (a) Not only a broad knowledge but also a strong ability in solving engineering research problems; (b) Not only an expert in a field but also a capable organizer; (c) Not only capable of solving actual problems in person but also good at cooperation with others and making full use of the momentum in different areas.

A key step toward sound management is the selection of topic and subtopic leaders based on the above criteria. In order for the responsible people to play a full role, there must also be clearly defined duties and responsibilities. Awards must be granted according to merit and achievements should be given timely praise and used as a basis for promotion evaluation. Inadequate performers should be given timely criticism and help. In major engineering research projects, full-time or part-time organization management personnel should be assigned according to actual need to help the leadership understand how the situation is progressing, solve problems and move the project forward.

(2) Timely organization and coordination should becarried out based on the nature of the subject and following the procedures of scientific research

Once the goal of the research and development mission is finalized, the first order of business is to justify the research plan. This justification is of great importance for engineering subjects because of their broad and general nature and because of the considerable manpower and material investments put into them. Since the schedule is tight and the work is heavy, the decision of research direction and technical proposal should be done carefully to avoid missing the opportune time and causing losses. For example, the development of a high temperature component used in space flight by one of the institutes involved the following aspects: research and development of heat resistant materials, investigation of machining and shaping technology, study of welding techniques, high temperature thermal coating research, investigation of nondestructive testing and setting up screening experiment facilities in simulated service conditions. All these areas must be mutually compatible and closely matched so that the mission may be completed on schedule in a coordinated progress. Therefore, when the plans are being discussed, project personnel as well as experts in the profession should be invited. Discussion should include the following areas: current status and trend of development both here and abroad, major components, approach and technical proposal of the research, milestones of the research effort, timetable and technical targets of each stage and expected completion time, equipment, material, and

capital construction needed in the project, total investment, annual budget and personnel replenishment, and so forth. Economic benefit must be taken into account in research and development. Comparison and analysis of technical and economic targets must be conducted in order for developed products to overcome the undesirable practice of not considering the cost in research. The main points in justifying a project plan are the approach and the technical plan. Through discussion, key points and the main emphasis of the development can be identified and appropriate actions taken accordingly. For example, in the development of a satellite high pressure vessel, there may be several proposals on material choice to satisfy the technical requirement: using low alloy, high alloy, super strength steel, or titanium alloy, the shaping technique might use punch pressing, rotary pressing or hot mold forging, and the welding technique may be argon arc welding, plasma welding or electron beam welding. In deciding which of the possible plans may be chosen as an acceptable one, decisions should be made on the basis of the mission requirement and various experts and technical personnel should play a full role. Through repeated discussion, verification and analysis, a practical, reliable and economic material and technique may be chosen.

The nature of engineering research topics requires the research and development unit to cooperate closely with the design and application unit in the development process. Design concept and service requirement should be communicated frequently in a number of ways, such as asking the design and service unit to provide design basis and reference data. Major technical specifications should be repeatedly studied and thoroughly understood. Another aspect is that, because of the limitation of various specialties, it is very difficult for the design staff to have an overall understanding of the material and technique and they may not make the most rational and economic material choice; on the other hand, the technical staff engaged in material and technique studies are unfamiliar with the service condition. Thus, the research management must organize the material and technique people and the design and application people and let them overcome their weakness by acquiring the other's strength through discussion, on-site visits and experimental participation. In one of the development assignments, it was required to punch grooves on high melting point metal plate. In the beginning, material was prepared according to the vertical and horizontal malleability specification submitted by the designers based on their information. But cracking flaws frequently occurred in the shaping process of punch pressing. After further study and analysis, the specified requirement was really the forming ability. To improve the forming ability in punch pressing, the rolling technique was improved. The original unidirectional rolling was changed into commutating rolling. Although this has made the horizontal malleability lower than the specification but each plate was successfully formed and thereby solved an old difficult problem of forming and satisfied the mission requirement.

An obvious feature of engineering research is that design development and application must form an organic system. In order to optimize the system performance, not only material and technique studies should be made according to design and service requirements, in the meantime the information obtained in the material selection and manufacture technique study should also be fedback in a timely fashion to design and service so that adjustment and

investigation consistent with practical needs can be conducted continuously to insure the smooth progress of engineering research and to obtain the expected results. Experience has proved that this is an effective method for speeding up research and insuring quality. In order to make timely exchange of information, research units should also send their staff to participate in the evaluation tests conducted by the application department so that they can be on top of the experimental situation and the material and technique related problems revealed by the experiment. This would help to accelerate the overall analysis and problem solving. In one of the engineering research and development projects the design and application unit requested the fabrication of a high radiation coefficient material. After screening and tests, the research and development unit came up with a high radiation coating which yielded good results under static tests. But in service performance tests the coating was found to show peeling effects under high temperature flushing. Later some bold technical innovation was made and the original coating method was changed. Based on the technical specification, a new method of obtaining high radiation coefficient was developed which solved the flushing and peeling problem altogether and satisfied the mission requirement.

In addition to timely communication between the research unit and the design unit, summary exchange should also be organized after the development work has progressed to a certain stage. The exchange of work summary, technical report and coordination between different units should be conducted simultaneously. Technical difficulties can be explored together in these coordination and exchange and conflicts may be identified and resolved. Through this practice, the design, application and development departments may be integrated into one entity. For example, in the development of the microthruster that controls the attitude of the astronomy satellite, a joint effort was made by the design unit, propellant development unit, and thruster material, welding, machining, and thermal protection units. Although these units are different in terms of academic field and specialty, the product they developed was used in the same subsystem. Because timely coordination and exchange were made and the units cooperated very well, it took only 2 years to complete the basic development of the prototype and progressed faster than the development of the whole system.

(3) Effective measures should be taken to insure quality.

How to insure the quality of engineering research is a pivotal question. In the past we used engineering management method as a guide and set up quality control cards for the developed components. To guarantee the quality of the development we must first establish inspection and verification standards for the parts. Since quality improvement is involved in the entire process of research and development, a rational standard for inspection and verification is often established with the successful development of components. A better method is for the design unit and the development unit to consult and determine quality standards for the various stages of development based on service requirements and the practicality of the techniques at different development stages. The inspection and verification standard is finally determined after an overall evaluation of the service performance. Different

quality standards may be formulated for different stages of the component such as preliminary specimen, test specimen and regular specimen. Each stage should be modified, supplemented and perfected based on experimental results.

To have each working process implemented rigorously in accordance with the quality standard, we must establish operation standards and a clear-cut technical post responsibility system and assign someone to be specifically responsible for quality inspection. Quality inspection circulation cards should be set up based on quality inspection standards. They have the function to transmit a timely quality information record of the components. The following information should be included on the cards: all the inspection items in the inspection and verification standard, quality inspection and appraisal results for each working process and the signature of inspectors for each process. To insure quality control in the development process, we must have a specific rules that once quality problem appears in a certain process, it should not be allowed to go on to the next process so that problems may be discovered in time and corrected in time. Once the product is finished the project leader or the institute's science and technology office should summon a joint quality inspection meeting where the responsible people for each working process will conduct an overall quality evaluation of the component based on quality inspection and verification standards. Components meeting the quality standards will be approved by the unit and sent to other units to be used.

The card method described here has been successfully used in several priority engineering projects. We have double checked several tens of thousands of measurement data points on developed components and did not find one error. The continued improvement of component quality has insured the reliability and repeatability of the developed parts. Experience has shown that using quality circulation card is an effective method to transmit quality control information and to guarantee the development quality of an engineering research.

(4) Organize the task group and carry out unified management

Specifically for the interdisciplinary and interprofessional nature of engineering research, one of the institutes must organize a task group that is above the research offices for the sake of a smooth progress of the research effort. In carrying out a centralized unified management, the project progress and quality control are both unified and coordinations within and without the institute are also unified. The technical personnel in the task group still belong to their respective research offices in terms of organizational relation, the task group is a temporary flexible organization. Only mission-related scientific research is unified, coordinated and directed by the task group and the research office and groups should assist the task group to insure a successful completion of the assignment. The task group must have the support of the institute leadership and possess a certain authority if it is to be flexible in coordination and quick in problem solving. The person in charge of the task group should devote some effort to policy-type work such as decisions of test programs, quality control, project summary and general evaluation. The routine organizational coordination such as quality

management, implementation of progress schedule and coordination of progress are duties of specially assigned people by the office of science and technology.

To insure the completion of the overall research and development project schedule, a unified project timetable must be set up and the relationship and progress of the mutually constraining and coordinating subtopics should be displayed graphically. The project schedule is a unified progress arrangement imposed on each working process so that the overall mission requirement can be satisfied. In the schedule, different parts of the task and various working processes are arranged according to their sequential order on the time coordinate. If several or a group of components are being developed, then there may be several development schedules going on simultaneously. These development lines constrain and cross each other and the development period of the entire component group is determined by locating the weak links in development and the development line with the longest period. The organizational coordination activity of the development is therefore centered on solving the weak leak and the work with the longest period. The linkage between the working processes is also worthy of attention. In order to guarantee the progress of the development, we must be practical in formulating the schedule and pay attention to discovering and solving problems in the development process and carry out some local readjustment. In formulating the overall schedule, responsible persons for each working process will report the time required for the completion of each process and general consideration will be made to identify those processes that may proceed in parallel or in alternation. Based on the coordination of different parts in the whole system, an overall development progress schedule can then be formulated and issued to various subsystems and working processes for earnest implementation.

The management method described above is a strong insurance for the completion of a series of engineering research assignments.

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LOCAL DEVELOPMENT IN SCIENCE, TECHNOLOGY DISCUSSED

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 1, Jan 82 pp 65-67

[Article by Yu Shangwei [0827 1423 1218] of the Jiangxi Provincial Institute of Scientific and Technological Information: "Several Problems Concerning the Plan for Local Development in Science and Technology"]

[Text] In June and July 1980 we investigated the result and application of major scientific research projects of local industrial, communication, financial and trade profession in the several years before the Third Plenum of the 11th Party Central Committee for the purposes of consolidating experience, drawing on the past lessons, correctly formulating local development plans in science and technology, improving the actual application of technological results, combining science and technology more closely with the material economy and serving the current local development of the national economy.

In those several years, the industrial, communication, financial and trade professions in this place have used a total of 13 million yuan three-category expenses on science and technology and conducted 188 applied and development research projects including 73 new product experimental manufacture projects, 12 intermediate testing projects, and 103 major scientific research projects. The survey has verified that 111 projects or 59 percent of the total number of projects have been completed at a three-category expense of 4.8 million yuan or 36 percent of the total expenses; 77 projects or 41 percent of the total number of projects were not completed and the three-category expense of the uncompleted projects is 8.8 million yuan or 64 percent of the total expenditure.

The application and popularization of completed projects may be divided into the following cases.

The first case refers to projects that have already been applied and popularized, experimentally manufactured new products have already been put into official production, technological results have been applied in the development unit and promoted to other professions and units and have had relatively large effects on the construction of the national economy. There are a total of 18 projects in this category, representing 9.6 percent of projects that should be applied and promoted. Among then 13 projects were completed by

plant and mine enterprises, 4 were completed by research institutes and only one project was completed by an institute of higher learning. Most of these projects are experimental manufacture of new products that sell well, none of them is intermediate testing.

The second case refers to projects that have been applied but not popularized, 64 projects or 34 percent of projects that should have been applied and popularized belong to this category. Some of these projects have had milestone results of relatively high scientific and technological standard, a few prototypes and samples have been tested in production and showed potential economic advantage. If experiments were continued into industrialized production, pronounced economic benefits would have been derived. These projects share a common feature, they are all completed with the cooperation between plant and mine enterprises and scientific research organizations or institutes of higher learning. Some of the results have been applied in host units with certain economic benefits, they could have been promoted to other professions or units but were not. Some of the results were applied to production but due to various reasons were discontinued later.

The third case refers to projects that were not promoted or applied. These projects were completed, even passed research appraisal, but the results were never applied in production and remained in the sample, display item, or gift stage and have not been transformed into commodities. There are 29 projects in this case: together with the 77 uncompleted projects, they represent 56.4 percent of projects that should have been applied and promoted.

We have made preliminary statistical analysis of the project completion and technological result application and promotion by the four different research units in large enterprises, medium and small enterprises, research organizations and institutes of higher learning. Analysis results show that, as far as applied research and development research projects are concerned, medium and small enterprises have the best record for completing research projects, scientific research organizations are second, large enterprises are next and institutes of higher learning come in last. This indicates that medium and small enterprises have the highest motivation to gain production, quality, profit and labor production rate from science and technology. In the area of promoting result application, large enterprises are most successful, research organizations come in second, followed by medium and small enterprises and institutes of higher learning again come in last. This indicates that large enterprises have the strongest technological force, the widest sources of capital and the best condition for promoting technological results. It should be pointed out that a very limited number of projects were surveyed and statistical significance may now show up, but statistical results for a specific case are still of reference value.

The survey showed a large effect of the "leftist" thought on the health development of local scientific and technological enterprise. Elimination of the "leftist" influence is therefore a prerequisite for properly formulating the development plan of local science and technology. The survey report conveyed the following important revelations.

1. In choosing local scientific research topics we must consider the specific need and feasibility of the local economy and society development and choose research subjects closely related to the actual production of the area. Research of production technologies that are widely used and have a bread impact should be strengthened in the various departments of the national economy. Plants and mines should be used as the experimental bases to encourage and institute collaboration between research organizations and institutes of higher learning and the plants and mines. Current shortages in research manpower, material and funds should be compensated by developing cooperation and the advantages of individual units. We should promote early and fast results and quickly promote the application of technological results in plant and mine enterprises to obtain prominent economic benefits. For example, in the development of sequential controller, the research was based on the actual production and a composite technological and economic target was properly proposed. Medium and small scale MOS integrated circuits give the product advantages such as high degree of integration, simple in structure, small in volume, light weight, low power consumption, and low cost, so that medium and small enterprises are able to afford and can easily use and maintain the product. In addition, anti-interference measures were incorporated in the design, the product performance is stable and reliable. It provided favorable conditions for promoting sequential control technology in industrial production and for achieving single machine automatic production and small scale assembly line.

Conversely, when research topics were chosen not on the basis of actual production, incompatable with the research ability of the unit and only blindly after sophistication and following the fad, nothing would be accomplished. A typical example is the development of the sugarcane harvester. This is a difficult task, but it was assigned to a county farm machinery plant for development. The plant had only a few technicians with a secondary vocational school education and a weak technical base, although 100,000 yuan were invested, not even a prototype was developed in 8 years. In those years, more than 50 agriculture machinery research topics were organized in 20 to 30 locations in the area and spent 1 million yuan. Although some research prototypes were made, most of them were not mass produced because they were too far removed from the actual needs of agricultural production. A few of the farm machinery that were put into production did not sell well and there was no popularized application to speak of. Another example is the automatic pork processing line and the electronic scale acquired by a meat processing plant, the automatic pork processing line was never put in operation and just sat on the sideline. These lessons are hard to forget.

2. In choosing the topics for local scientific research, we should pay attention to the technological sophistication and economic sensibility as well as social feasibility. The choice should benefit employment and standard of living improvement and should not cause environmental pollution and ecological disruption. That is to say, scientific prediction and technical economic arguments must be considered in formulating a local science and technology development plan in order to avoid choosing the research topics blindly. A hydraulic pressure component plant began to develop a "new" gear pump in 1976 without carefully gathering and studying relevant technical information; after working on the development for 3 years, it dawned on them that the product they tried

to develop has already been phased out by others. Another example is the development of small generators using aluminum to substitute for copper. Having conducted no economic analysis, not understanding the actual situation of domestic resources and not following the correct technical policy, the project began in ignorance and the prototype produced was a pile of junk. Then there was the project of producing potassium fertilizer from potash feldspar. The project made use of local resource but did not analyze the economy carefully. When the product was transported to the nearest town, it cost more to transport the product than the sale price, the product did not sell, the enterprise could not operate and was forced to close down the entire facility purchased with the three-category expenditure and had to switch to produce other products. A further example is the production of a new small killing agent to eliminate schistosomiasis from south China. This new drug can effectively kill the snails but it also poisons fish and other aquatic creatures and produces ecological damage, as a result, industrial production cannot be arranged. The examples go on and on.

3. Local science and technology development plans should include two parts: major research projects and the promotion of research results. Scientific research management systems must be perfected to ensure the basic conditions for scientific research and effective measures must be taken to strengthen the promotion of the application of research results. Under socialism a common feature shared by everything is planning. The formulation of a research plan is a strong guarantee for the development of the science enterprise. Of course, when we emphasize planning we should also adjust the planning with economic means.

In the survey we found many research projects that are promising and valuable. These projects should be given high priority for inclusion in the local research plan and should be guaranteed for necessary expenditure. Otherwise, without sufficient funding and the necessary facility and equipment, these projects would have to fold in mid-course and good opportunities would be missed and there would be avoidable losses. For example, the research of producing polyhydric alcohol by hydrogen glucolysis opened up an avenue for producing Shan-li-chun with noncrop material and satisfactorily solved the problem of general use of surplus syrup in sugar mills. After the preliminary tests were appraised in July 1977, adjacent provinces were ready to introduce this research result, but the research unit could not solve the expense problem for intermediate testing and the preliminary result has therefore failed to pan out.

The reason that research results were not promoted and applied is largely due to the lack of a unified special management organization and the absence of a detailed practical plan and because specific coordination measures were not taken. Especially the departments in charge of material, price, commerce, bank and tax did not provide the necessary help and support for the promotion of research results and the experimental manufacture of new products.

After the state science and technology commission made the suggestion in February 1980 that agriculture research results should be promoted with local, time and personnel factors taken into account, a local science committee

made use of science and technology three-category funds and organized the technological force, promoted agricultural technological results in several communes and increased production in these communes even with relatively serious natural disaster and when many other places suffered decreases in production. For example, the rice production of one commune increased by 2.82 million jin compared with the previous year and each member had an average income increase of 39 yuan. This is a strong proof that when research results beneficial for production development and standard of living improvement are included in the promotion plan and given funding assurance, they can be rapidly promoted and applied and economic benefits can be derived from them. This is true for the promotion of agricultural technological results, and it is also true for the promotion of technological results in industry, communication, finance and trade professions.

Today a number of good ideas have been proposed regarding the protection of technology and the transfer of technology with compensation. But in local areas, there are few special research organizations, the technological base is weak and research facilities are unavailable, only very limited research topics can be undertaken by local areas. Research results sold by local research organizations, even combined with those sold by departments and commissions of the central government, are only drops in the bucket for the local construction of the national economy. The important thing is to formulate economic policies and measures that encourage the plant and mine enterprises to conduct technological development and promotion, because a great number of research projects are carried out by plant and mine enterprises and projects receiving awards in the national science conference and local technology awards are also mostly conducted by plants and mines. Therefore, local finance departments should sponsor plant and mine enterprises to promote their own research results or the transfer of research results from other units. This funding should be included in the local science and technology development plan and other avenues of resources such as "science and technology development foundation," "technological improvement foundation," "capital construction investment," "self-raised capital" and "loan for technological measure" should also be coordinated to create the necessary conditions. The approach of "if it doesn't work, make it work" probably would not succeed. For example, an oil and fat chemical plant successfully produced cocoa fat substitute with hydrogenated cotton seed oil which could completely replace imported cocoa fat and save 10 million yuan per year. It solved a major technological problem in the production of chocolate foodstuff in China and could not meet the market demand. But this plant could not get the support of the pertinent departments for funds to add facility and for the supply of the cotton seed oil, as a result, a promotion project with great potential has been in limbo for a long time.

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IMPORTANCE OF DEVELOPMENT OF RESEARCH INSTRUMENTS VIEWED

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[Article by Zhou Li [6392 7812] of the Chinese Academy of Sciences' Space Center: "Attach Importance to Problems in Developing Scientific Research Instruments"]

[Text] In the history of the world's modern science development, it takes three conditions to achieve scientific and technological modernization within a short period of time, namely, a certain number of high quality scientists, advanced experimental facility and scientific management method. These are the three essential elements in developing research. In addition, policy, management system and the development direction of technology also play important role under certain conditions. In this article, we restrict our discussion to laboratory construction and ways to create sound experimental facilities.

The Importance of Improving Laboratory Facilities

In the microscopic world the subject of study in modern science has reached the interior of "elementary particles" and the ultrafine structure of material. Macroscopically, the world has extended over tens of billions of light-years of space. All these require constant renewal and improvement of laboratory facilities. In scientific research, measurement is an important method to the understanding of nature by combining theory and experiment and it is a procedure in which scientific research and technology are intimately combined. Through measurement, we can give qualitative and quantitative understanding and a concept of natural phenomena. The higher the measurement precision, the greater the probability of correctly revealing the laws of nature and the greater the ability to modify nature. Therefore, a nation's scientific level may be evaluated by the precision of its measurement standard and the technological performance of its measurement facility. Measurement helps the development of science and technology and the development of science and technology in turn promotes the improvement in measurement technology. Scientific research and measurement are complementary and inseparable and together they form an organic feedback loop.

The history of scientific development has shown that good experimental facility allows experimental work to open up, shortens the time of experiment, speeds up research progress and leads to prominent results. Examples are numerous. The invention of the telescope made possible the discovery of sun spots and the 28-day period of self-rotation, the numerous star clusters making up the galaxies and the rough surface of the moon. The use of the microscope advanced the development of cell biology and proved that protoplasma and cell, the structural components of all organic bodies, are the lowest level independent living organisms, verified the existence of blood capillaries which connect the artery and the vein, discovered the world of bacteria and made invaluable progresses in bacteriology, anatomy, medicine, biology, chemistry and physics.

In the last decade, technological methods in the world have been widely improved whether the technologies are for the analysis of the interior of the atomic nucleus or for the exploration of the outer reaches of the solar system; whether in the analysis of material structure or the material composition. Most of the technologies make use of computers for system control or data processing. Computers have not only reduced the labor of the operators but also accelerated the progress of the experiment. For example, a computer controlled radio telescope has discovered more than 30,000 radio sources in the universe, observed stars 10 billion light-years away, and discovered the spectra of intergalactic organic molecules and the 3°K microwave background radiation. These discoveries have given high energy physics research and the study of the origin of life a tremendous boost. Conversely, the loss caused by inaccurate measurement can also be shocking. For example, due to inaccurate field strength measurement, the gain of an expensive antenna in the United States has to be increased specifically for the measurement error, an increase of 1 dB of gain in each antenna caused an added expense of $50,000.

In short, modernization of science and technology must be backed by a modern measurement facility. In order to obtain high quality major breakthroughs in research, one must have advanced measurement equipment. Normally, measurement equipment is an important "front man" in scientific research. Naturally scientific research itself is also continuously solving problems in measurement and providing new measurement equipments. In the rapid development of science and technology, newer and more complex disciplines and branches of science and technology will undoubtedly emerge and the development and production of newer and more advanced measurement equipment must also follow suit; otherwise, the modernization of science and technology will be hampered.

Characteristics of Equipments Used in Research

1. The making of equipment goes from simple to complex and from crude to sophisticated. In the process of research experiment, researchers begin by building some simple instruments themselves and as the investigation develops some of the simple equipments are phased out when the research subject concludes and some of them are improved and perfected gradually and evolve into a new model of instruments along with research development. For instance, some of the equipments become high efficiency purification and extraction instruments, some turn into high speed separation equipments, some evolve into

complete synthesizing setups and others become various electronic instruments that measure the results of the research.

2. As technical science develops, so does equipment used in scientific research. Electronics, computers, low temperature equipment, optics, and automation are just a few examples of the technologies. Scientific instruments today have become an integration of many technologies and are made up of different equipments. Development of technical sciences directly affects the development of scientific equipment. For example, in the field of electronic measurement alone, the technology has reached the fourth generation or the "electronic technology era." Measurement techniques and experimental equipment are unprecedented in terms of method, variety and scope of application. With today's highest standard electronic equipment, the smallest quantity measurable is 10^{-19} Farad, the largest quantity measurable is 10^{18} Ohm, the lowest frequency measurable is 0.000001 Hertz, the highest frequency measurable is 148 Gigahertz. The highest accuracy in frequency measurement is 1×10^{-10} and the highest stability is 10^{-16}/sec. The problems of background noise must be overcome in achieving these extremes in measurement.

After several decades of development and change, electronic instruments have gone through vacuum tubes and transistors and are now made of integrated circuits, which are the basis for today's miniaturization, digitization and the solid state approach. Development continues toward automation, integration, digitization, high precision, multiple function and wide range (large dynamic range). Scientific instrument and equipment cannot get away from electronic instrument and technology, the precision and stability of scientific equipment are also affected by electronic instruments.

3. The technical specifications of measurement instruments used in scientific research should be one or two orders of magnitudes higher than production equipments. This is because quantities to be measured in experiments are mostly unknowns of an exploratory nature. In this sense, there will be no results and no achievements without measurement and analysis. New developments, discoveries and techniques always pose new technical specification and definition. Moreover, because of the exploratory nature of scientific research, parameters measured in the investigation process often need support from other measurements. Measurement method and requirement in scientific research also vary greatly. Therefore, the performance of experimental equipments is expected to be higher than that of production equipments.

4. A scientific instrument should have short measurement time and high measurement speed. We all know that the shorter the experiment period, the faster the research progress. Particularly in repetitious and continuous experiments, it is even more important to obtain measurement and analysis results as rapidly as possible. In today's developed nations, computers are widely used in operation control and data processing to speed up the progress of experiment and shorten the experiment period. When researchers finish their work and go home, the experiment and measurement do not stop. Thus, experiments requiring several years in the past can now be computed in only a few days or even a few hours.

Current Problems in Developing and Producing Research Instruments and Recommendations

1. Among thousands of instruments and equipment , which instruments should we concentrate our effort to develop? Instruments used in scientific research can be divided into three types. The first type is large-scale experimental equipment. Whether for special use or for general use, the development of large experimental equipments involves complex technology, large investment and long building time. In foreign countries this is usually managed by system engineering methods. These types of projects are generally priority engineering projects of some units. As long as they are well organized and carried out scientifically according to objective laws, they can be completed on schedule. The second types are general instruments and meters. They are used not only in scientific research but also in industrial and agricultural production process. Institutes of industrial departments have already achieved outstanding results in improving these general purpose instruments and meters. The third type is relatively special purpose instruments used for structural analysis and composition analysis in research. This type of instrument should be given priority in development and manufacture. It includes the seven major instruments (optical spectrograph, chromatograph, mass spectrometer, energy spectrograph, nuclear magnetic resonance spectrometer, and electron optics and ion optics equipment) widely used in chemistry, biology, earth science, oceanography, physics, new material and new device research. These equipments are special instruments to some departments in industrial and agricultural production but they are general purpose equipments for scientific research. One more difference is that in scientific research the measurement ability of an instrument should improve continuously along with the development of research and the instruments are required to have high precision, wide range, high speed and multiple function. Hence we should concentrate on the development and mass production of these high quality and stable instruments.

2. Over the years we have obtained good results in organizing the development and manufacture of research equipments. But in the area of management, development and production, we have always been relatively weak and lacked management personnel, overall survey systematic analysis and effective measure. As a result, we have not mastered the trend of development of laboratory equipments, the intrinsic rules of development production, and the current status of the technical force. We do have some statistics but we have not identified and solved the problems using these statistics. We should now draft some qualified comrades and organize a special unit for the development and production of scientific instruments, conduct extensive survey both in China and abroad and identify some typical problems, then we can organize and implement projects to develop and produce scientific research instruments, coordinate various technical problems in this development effort, formulate specific technical plans and get this work underway.

3. Strengthen technical ranks. In our learning of advanced foreign technology, some comrades have the wrong idea that we can successfully copy any foreign instrument that we buy. But things are not that simple, because modern scientific instruments are not the simple electrical and mechanical equipments of the 1930's, they are instead composite instruments using a

variety of complex technologies. Without accumulated technical knowledge and development in applied technology based on applied research, imported technology cannot be "licked." For example, Changchun Institute of Applied Chemistry and Hubei Institute of Physics assumed the responsibility of developing 100 MHz NMR spectrometer. At that time China had already imported about ten 90-100 MHz NMR spectrometers but many other institutes were not able to take on the job because they lacked the technical ability in this area. The two institutes in Changchun and Hubei, based on their experience in magnet characterization, machining technique and spectrometer from developing 60 MHz NMR spectrometer, conducted dozens of tests and improvements and obtained good results after 5 years of hard work. This experience has proved that, without a professional, technical rank and accumulated knowledge on applied technical research, it would be very difficult to copy advanced imported instruments. We therefore recommend a serious effort in organizing a technical team in this area. We should improve not only the technical staff of special instrument plants but also the technical staff of research institutes and let them develop their initiativeness and specialty. Changchun Institute of Applied Chemistry and Hubei Institute of Physics are experienced in developing NMR spectrometer, Dalian Institute of Biology, Shanghai Institute of Biochemistry and Lanzhou Institute of Chemistry have formed a formidable team in chromatograph development, Changchun Institute of Optics and Fine Mechanics and Shanghai Institute of Technical Physics have trained a technical team on optical spectrograph, Anhui Institute of Optics and Fine Mechanics, Shanghai Institute of Optics and Fine Mechanics and Shanghai Institute of Electronics are still far ahead in laser development. As long as we consciously organize the technical forces of these institutes, we will not only digest the imported instruments faster but also make innovations in modeling these instruments.

4. Solve the problems existing among the technical personnel and motivate their activity. Some comrades in the present system of research institutes are discontented with their technical jobs and feel that the organization has not given adequate attention to technical work. Moreover, the pay of technical personnel is low whereas in foreign countries the salary of technical staff is often higher than that of researchers. If this problem were not solved, it would certainly affect the motivation of many people.

The foundation of our scientific and technological modernization must be placed in China. In the area of foreign technology we should only bring in model instruments and patents, the larger number of instruments must be built with our own hands. In the hands of technical personnel, researchers' new ideas are turned into new experimental instruments. In the process of building up a laboratory, both copying new equipments and improving old equipment rely on the technical staff. It is therefore particularly important to formulate policies governing the technical staff and motivating the wide ranks of engineering technical personnel. In addition, we recommend that the number of technical personnel in delegations visiting foreign countries should be appropriately increased because "they can figure out new things and technologies just by seeing them"* and produce instant effect. Finally, frequent special technical meetings and experience exchange will also promote the development of technology.

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*Note: Premier Zhou's comment on a report by the Ministry of Foreign Affairs and the Ministry of Foreign Trade regarding the exchange of observation groups between China and Britain.

5. In the development of laboratory equipment, we should go beyond the boundary of discipline and have unified planning and organization. It is advantageous to improve the system according to academic discipline, but in building up a laboratory it is better to have unified organization. For example, high efficiency chromatograph is a necessary analysis tool in biology, earth science, and chemistry; if the organization is not unified there will invariably be repetitions and wastes. On the other hand, if the technical pool is organized and equipment developments are assigned to various institutes according to their natural division and based on the specialties of each institute, then not only the institutes can develop their technical capability but the components developed will be characteristic of the institute and the equipment built will be more stable. Besides, when each academic discipline organizes their own equipment development effort, then, because of the non-uniform technical capability there will be great differences in strength.

6. Develop the potential of institutes and plants to form a base for intermediate experimental production of new products. After scientific instruments are developed, they often fail to be popularized. There are a number of reasons including instability of electronic components, technical problems in instrument function, problems in manufacture technology and limited usefulness of the instruments. At the present there are four problems in instrument development urgently awaiting solutions.

(1) Make the product quality stable and reliable and make the technology mature. (2) Based on the current development capability, draw on advanced foreign technology and improve the ability. (3) Gradually use computers for procedure control and automatic data processing in all the instruments developed. (4) Combine different instruments and equipments to form general purpose analysis and test equipments.

Among these four problems, the key item is the first one. To solve the quality and manufacture technology problem, foreign countries often invest to build an intermediate experimental production facility. In China, it is difficult to come up with more funds, but the manufacture quantity of plants is very uneven, some plants have great potential for development and can be organized to assume the duty of intermediate experimental production of certain new products. When we organize this effort, we must be patient and do it carefully and thoroughly. After the situation is well understood, test runs can be made in qualified plants and unqualified plants can be organized later after they gain some experience. If we do this, we will on the one hand equilibrate the production of plants and on the other hand accomplish the job of intermediate experimental production. This approach not only will cultivate technical personnel but will also save the state a great amount of investment. It will solve the product popularization problem and the laboratory equipment problem at the same time.

In the space above we have only brought up some issues. The actual implementation would be impossible without a system of tried and true methods and a leadership group that is familiar with the profession and has a strong ability for organization.

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LAWS OF DEVELOPMENT OF NATURAL SCIENCES DISCUSSED

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 1, Jan 82
pp 2-8, 59

[Article by Luan Zaochun [2940 2483 2504] of the Heilongjiang Academy of Social Sciences: "Laws on Development of the Natural Sciences"]

[Text] All things in the world follow certain objective laws in their development, natural sciences are no exceptions. The so-called laws are recurrent relations in the essence of events. Our task is to explore the objective laws of development in the history of natural sciences and use these laws to guide our future work.

Science is a system of theoretical knowledge and natural sciences reflect the objective laws of nature. The development and evolution of natural sciences is invariably dictated by the objective laws of nature and the laws of theoretical knowledge development and progress.

Science is also a product of history and is produced under a certain historical background and social condition. Scientific activity is an important social activity and its development and change are always influenced and constrained by social factors such as economy, politics, military and tradition. The development in science is therefore controlled by the laws of social development.

We therefore examine the laws of development of the natural sciences from the "knowledge history" and "social history" aspects of the development in natural sciences and seek the laws of development of the natural sciences from the dialectic relationship between "knowledge history" and "social history."

Today the viewpoints regarding the laws of development of the natural sciences are very inconsistent, some people even deny the existence of such laws, and there has not been a unified understanding. In this paper the author extracts the reasonable portions of different views and propose some bold and tentative arguments based on the fundamental viewpoint discussed above for the purpose of discussion and study. I believe the development of the natural sciences obeys the following laws.

I. The Law of Proper Sequence and Steady Progress in the Development of Natural Sciences

The enormous system of natural sciences is the result of gradual development in the course of several thousand years of human history. The accumulative, gradual, continuous and sequential nature of scientific knowledge exhibits a law of proper sequence and steady progress in its development. The development of scientific knowledge is gradually from less to more, from simple to complex, from low to high, from diffuse to systematic and from singular to compound.

Science is a system of knowledge of reason. Different points of view and schools of thought are formed in exploring and seeking the answers to questions such as how is the knowledge of reason produced? How does the knowledge of reason develop and evolve? How are disciplines of science formed from these knowledge of reason? How do the different fields evolve and develop? And what relationships exist between different fields of science? The Marxist theory of knowledge provided answers to these questions in principle and it is the theoretical basis of our understanding of the development laws of natural sciences. Some Western natural philosophers have also proposed many different points of view and we should critically absorb the sensible portions of them.

In the West there has been a inductionism viewpoint of science regarding the generation of scientific theory. This viewpoint was first advocated by British philosopher Francis Bacon, who proposed that experience is the foundation of all science, and scientific theory should be derived from the observation of facts and the inductive method. Bacon's viewpoint was developed by Muller and Spencer and gradually formed the current induction philosophy in the 20th century. From the induction viewpoint science is the knowledge derived from factual experience and verified by experience. There are two basic principles in inductionism: (1) Science begins with observation and observation provides a reliable foundation on which scientific knowledge is built.[1] (2) Scientific knowledge is derived from observation and description with the aid of inductive principles. Based on these principles, the certain conclusion is that science development is accumulative and progresses steadily. The model of the inductive view of science is as follows:

Observation $\xrightarrow{\text{induction}}$ principles and theory $\xrightarrow{\text{deduction}}$ interpretation and prediction

The desirable feature of inductionism is that it emphasized the important role of observation and experience in the generation of scientific knowledge and proposed an accumulative and gradual development model for science. But inductionism has its shortcomings too, it overemphasized the function of observation as observation may be erroneous and mere observation cannot guarantee the correctness of all the theories obtained. Inductionism has its limitations also, and merely relying on inductive method cannot guarantee correct conclusions deduced from factual observations. The elevation from perceptual knowledge to rational knowledge not only requires many different methods of

logical thought (not only induction) but also needs the repetitive process of "cognition--experience--recognition--reexperience."

We should not accept the entire inductionism; instead, we accept only the rational part of inductionism. In the meantime, I am also against totally abandoning the induction philosophy. Induction has its place in science history and the inductive method is a desirable method of logic thought. Newton claimed that his laws of motion were not speculation, they were truthful description of the facts and they were built using the induction method.[2]

The overall trend in scientific development is accumulation and steady progress, but in the long history of science, the rate of progress is not uniform, the development is sometimes fast and sometimes slow. In the development of modern science and technology, there is an evident trend of accelerated development. Scienologists Bernard and Price have proposed a theory of exponential growth of science known as the law of "accelerated development of science." Scientists analyzed the quantitative change of scientific investment, science and technology staff, scientific publications and papers and major discoveries in the development of history of modern science and discovered each of the above doubles in 10～15 years.[3] Although this "law" correctly pointed out the development trend of modern science, the "law" does not hold. A law is a recurrent relation in the essence of the events, the law of exponential growth of scientific development cannot hold since it is not recurrent. If calculations were made according to this exponential law, they lead to the absurd conclusion that before long the number of scientists would equal the total population of man. Hence this law does not hold true. It merely reflects the development speed of science in a brief historical period.

Scientific development is not only manifest as accumulative and progressive, it also shows rigorous inheritance and orderliness. The tower of science was built with the efforts of generation after generation, modern man can continue to add bricks to the tower of science only on the basis of mastering the scientific achievements of the previous generations. The first thing a scientist does is to inherit and master the scientific achievements of previous generations and contemporaries by learning, otherwise he cannot accomplish new scientific achievement. Scientific research activity is a process of using the "known" in exploring the "unknown." Numerous examples in science history attest to this. For example, the three laws of Newtonian mechanics are entirely built on the achievements of previous scientists. It would have been impossible for Newton to propose his great theory in 1687 without the three laws of planetary motion summarized by Kepler and many dissertations on the law of gravity by scientists of that era (1645-1680) (for example, Hooke had fought Newton for the credit of discovering the law of universal gravitation) and Picard's accurate determination of the earth's radius in 1671. Newton's remark that he "stood on the shoulders of giants" is totally consistent with the objective law of development of events, induction and integration is itself one kind of creativity. If there were no Newton, there would have been other scientists accomplishing his discoveries because the time and condition were exactly right for the discovery of the three laws of motion and the law of universal gravitation, Newton was merely the "favorite son of the era."

The orderliness of science development manifests itself in the sequential and limiting nature of science discoveries. In the 17th century when the understanding of the microscopic world was still a void, Newton investigated the laws of motion in the macroscopic world and Newton could not have discovered quantum mechanics and relativity. Only after Dalton's atomic theory and Planck's quantum theory did Einstein discover relativity. If the laws of motion of the solar system were not understood, it would have been impossible to discover the laws of motion in the Milky Way. If the structure of atoms were not understood, it would have been impossible to discover the structure of the atomic nucleus. Only after the nuclear structure is understood, then it is possible to probe into a deeper level--the mysteries of the elementary particle structure and establish and develop high energy physics. Material movement in nature has a certain sequence and the development of scientific theory progresses gradually according to the sequence of material movement. Theories of the next level can be developed only by inheriting theories of the previous level. At the time of Einstein, there was little understanding of the structures on the elementary particle level and as a result his attempt to explore the unified field theory did not succeed. Even a great scientists like Einstein working for 30 years could not violate the objective law and achieve results before its time.

The accumulative, progressive, inheritive and sequential nature of science development constitutes the law of proper sequence and steady progress in science development. This law provides guidance in our effort of scientific research, technological improvement and science education. In our scientific research effort if we hasten to tackle problems in frontier science and impatiently set out for some high scientific goal before we can even handle the results of previous scientists and understand the law of material movement on a previous level, we shall only waste our time and be doomed to fail. We should learn from Newton to stand on the shoulders of giants, integrate the accumulated scientific achievements and then try for a breakthrough and obtain major results within a short term.

In development research we often see cases where the fundamental principles and basic components are not yet worked out but great effort and time are spent in developing the whole system without any success. "Haste makes waste," haven't we seen enough lessons?

We know the proper sequence and steady progress in learning very well; without a background of introductory mathematics, it would be futile to study advanced mathematics. For the same reason this objective law must also be followed in science research and technological creativity. We should humbly inherit, accumulate slowly and gradually develop; under no circumstances can this be scolded as "crawling."

II. The Law of Revolution in the Development of Natural Sciences

In the development process of natural science the progress is not always steady and gradual and it is not always a quantitative accumulation; instead, sudden changes and qualitative jumps in science theory occur in certain periods and we have a scientific revolution.

There are three representative views on the interpretation of scientific revolution, they are the counter proof of [Bopu], the revolutionary theory of Cohen and the scientific concept revolution theory of Einstein.

In 1959 Austrian philosopher [Bopu] proposed the viewpoint of counter proof. He objects to logic justification and believes that results of observation and experimentation cannot prove a certain theory to be true. On the contrary, results from observation and experimentation can prove a certain theory to be false. In other words, a theory cannot be proved true, it can only be proved false. He believes that science does not begin with observation but with a problem. Hypotheses to a specific question are first proposed, attempts are then made to prove them wrong, theories proven to be false must be discarded without mercy. He views the development of science as a continuous process of theories being proved false, or, it may be called a theory of "continuous revolution." His model of scientific development is as follows:

Problem ⟶ Hypotheses ⟶ Counterproof ⟶ New problem

The desirable feature of his theory is the emphasis on problems. Discovering a problem and raising a question is a sign of progress and a prerequisite for scientific discovery. Many famous scientists have posed questions and speculations which led to many important discoveries. Two thousand years ago, the great Chinese poet Qu Yuan raised 172 questions in one breath in his book; some of his questions are still unanswered. In 1978 an "Encyclopedia for the Unknown World" was published in America and Britain, the editors requested 56 famous scientists to list 51 special topics in 6 fundamental disciplines and give a general introduction to the phenomena unexplained by present scientific understanding or with a controversial interpretation. This book shall no doubt have a guiding effect on science research.

The shortcoming of [Bopu] theory is that he totally denies the role of experience in the confirmation of a theory and he totally denies the thought function of induction. Any theory can only be a general rule, there are always special cases in generality, totally disclaiming a theory because one special case is illogical. There are always stable periods in the development of science theory, there are also internal connections and inheritance among the various theories. The development of scientific theory is not like the process described by him in which scientific theories are constantly being proved wrong and continuously being discarded.

American scientists and philosopher Cohen believes that neither the induction theory nor the counter proof theory are consistent with historical facts, in his book "The Structure of Science Revolution" published in 1970 Cohen proposed a new viewpoint of science revolution. Cohen believes that scientific development should not be viewed as a simple accumulation of knowledge but one should also look at the qualitative change of science theories. Cohen stresses the role of science revolution, his model of scientific development is as follows

Prescience ⟶ Conventional Science ⟶ Crisis ⟶ Revolution ⟶ New Conventional Science ....

Prescience refers to the period of controversy before a systematic theory is formed, conventional science refers to the period after a systematic theory is formed. Conventional science is then put to actual practice and used in problem solving. Conventional science continues to improve until it encounters more and more difficult problems and a crisis in theory arises. Crises finally lead to a revolution in which the old theory is replaced by an entirely new theory, the new theory then enters its conventional science stage followed by new quantitative changes until new crises appear.

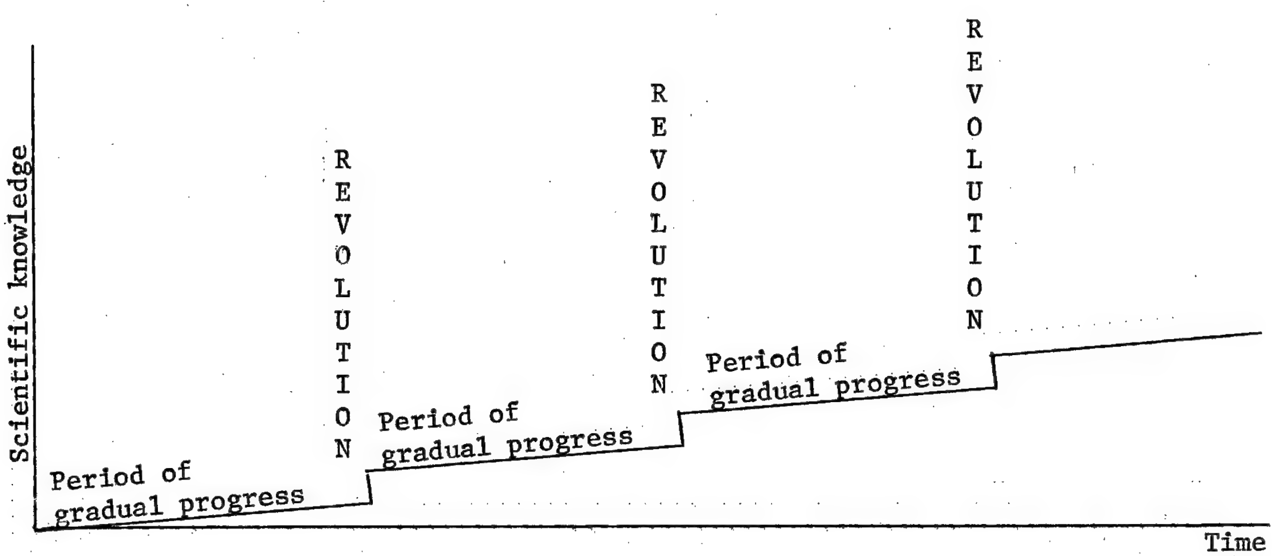
Cohen's emphasis on the qualitative change in the development of science theory is correct and this is a merit of his theory. However, his theory also has serious inadequacies. He overlooked the inheritance nature of new theory and the old theory and he overemphasized the incompatibility of the two theories before and after the revolution. In addition he denied that the goal of scientific advancement is the truth, he denied the existence of objective truth and disclaimed the connection between relative truth and absolute truth.

Einstein has made some profound discussion on science revolution. He proposed the idea that the history of scientific development is a history of scientific concept evolution. He believed that "fundamental concept plays the principal role in establishing a physics theory. Physics texts are full of mathematical formula but all the theories in physics originate from thought and idea, not equations." He also believed that people use mathematical formula to express the theory quantitatively only after the concepts are established. He thinks that "these fundamental ideas and assumptions which cannot be further simplified logically" constitute the "fundamental concepts" and "scientific concepts" which become the basic component of theory and play the role of an "axiomatic foundation." In a science revolution, the past experience and knowledge are not changed, nor are they discarded, only the criteria in understanding this knowledge and the theoretical framework of the knowledge change. In other words, only the fundamental concepts of science change.[4]

Einstein has not only emphasized the revolutionary nature of science development, he did not overlook the accumulative nature either, he put the two together organically. He revolutionalized physics by establishing a theory that replaces Newton's theory. Einstein's theory not only can pass the tests Newton's theory failed to pass and some further tests[2] transcending the realm of validity of Newton's gravitational theory. Einstein's viewpoint is more consistent with the objective and correctly reflects the history of science.

The law of proper sequence and steady progress and the law of revolution in the development of natural science are completely in agreement with the fundamental law of quantitative change to qualitative change in materialistic dialectics and with the development history of natural sciences. By combining these two laws we have the following picture of natural science development. In the long course of history the progress of natural science is sequential and gradual, scientific knowledge is constantly accumulated and passed on from generation to generation. At some stage of the science development, revolutionary changes in science theory take place. New theories at a higher level are more correct and broader than old theories; they not only can explain facts explainable with the old theory and predict more. The emergence of a new theory causes

major changes in the old theory and is followed by a period of proliferation until a newer theory appears. This development style is similar to walking up the stairs on a gentle slope, one walks a stretch and goes up one step, walks another stretch and goes up another step. I therefore call the model of natura natural science development the "gradual stair model," as shown in the figure below



Looking at the history of science, the progress of various fields are not uniform, some fields develop faster than others and some slower. The faster developing fields promote and help the slow developing fields. This is especially true in modern science and technology where the trend is mutual overlapping and penetrating and various fields promote each other and progress together. A major theoretical breakthrough or scientific revolution in one field affects neighboring fields or even the entire field of natural science. A field with theoretical revolution in a certain historical period that had a major impact on related fields and the entire realm of natural science may be called "revolutionary science" or "advanced science." [Kai-de-luo-fu] of the Soviet Union has proposed an advanced science development principle. He pointed out on the basis of science history analysis that the first advanced science was mechanics which lasted 200 years, the second advanced science was in the fields of chemistry, physics and biology which lasted 100 years, the third advanced science was microscopic physics which lasted 50 years and the fourth advanced science is again in the fields which include control theory, chemistry, aerospace aviation, nolecular biology, genetic science and physical chemistry. He predicted in early 1970 that these fields will serve as leading sciences for 25 years and will be replaced by a single science, perhaps molecular biology. [Kai-de-luo-fu's] theory is doubtful, his claims that the changeover period of advanced science is decreased by one-half each time and that a single field and a group of fields alternate are only a crude analysis and not a principle. Extrapolation of his theory will lead to absurd conclusions and the frequent alternation will also negate the leading role. A group of sciences or a large

number of fields mentioned above cannot realize the role of leading. But [Kai-de-luo-fu's] concept about advanced science still has its merits.

In the development process of natural sciences it is normal to have a period of revolution in which important theoretical revolution in one field causes major changes in the original science theory system, but we have not discovered the period of these occurrences.

Guiding our scientific research with the law of revolution in the development of natural sciences means we must get our hands on "revolutionary science" or "advanced science" and give it high priority support so that the results can quickly be spread into other fields and play the full role of a leading science. If it is within our power, we should concentrate our force to tackle a field where major breakthroughs are possible (circumstance and opportunity permitting); if it is beyond our capability, then we should actively employ the revolutional results of others and quickly exploit the achievement in the science and technology field of China and obtain more results in a short term.

In the space above we have explored the laws of development of natural science from the intellectual history of science development. Now we shall explore the laws of natural science development from the social history.

III. The Law of Promoting Science Development by Production

Engel's answer to the question of how did science begin was: "From the very beginning the occurrence and development of science was determined by production." Production is the source and driving force of science. Production activity is the fundamental activity of a society. Science is the purification and consolidation of rich experience in production. Increase in productive force leads to the division of manual labor and intelligence labor and science is the production of intelligence labor. In ancient history production activity was largely agricultural and forestry production. Improvement of agricultural production experience produced agronomy, geometry, calendar and irrigation and water conservancy sciences closely related to agricultural production.

Productive force is the fundamental driving force for social development and the need for productive force development is the fundamental need of the society. Essential elements of productive force are labor, means of production and object of labor. To improve the productive force, the worker must know advanced production technique and advanced means of production, these two elements constitute an advanced production technology. "Necessity is the mother of invention." Development in productive force pushes forward production technology and causes a continuous generation of new techniques. The need to develop new technology in turn moves the scientific development. If the generation of ancient technology is largely due to experience then the creation of modern technology relies mainly on science. For example, the need to develop space technology moved forward the development of space science, aviation technology promoted the birth of aerodynamics, and computer technology also promoted the development of computer science and semiconductor physics.

Therefore, from the viewpoint of production pushing forward the development of science and technology, the law of development of natural science is as follows.

Production ⟶ Technology ⟶ Science

Great developments in production also cause great developments in technology and science. Major development in production technology not only provides more research funds for scientific study but also provides more advanced experimental equipment and facilities and the development speed of science will be accelerated.

Looking back in history, the development of modern science and technology is accompanied by major capitalistic production development. A commodity economy propels technological and scientific development. A high tide in production and construction occurred during the first 5-year plan in China, accompanied by an upsurge in science in 1956. After the downfall of the "gang of four," a high tide in construction of the four modernizations emerged in China accompanied by the blossoming of science in 1978.

On the other hand, when the production development is slow or when the production is halting or in a destruction period, development in science and technology will also be in a state of stagnation.

From the viewpoint that productive force is the major driving force for social development, production activity is the source and impetus of science and technology production. However, a reversible dialectic relationship also exists among production, technology and science, that is, science ⟶ technology ⟶ production, and science may be ahead of technology and production and promotes the development in production. Although such a dialectic relationship exists, the entire history shows that the source and impetus for producing science still follow the basic law of production ⟶ technology ⟶ science.

IV. The Law of Science Development Constraint Due to Social Changes

"Revolution is the locomotive that moves history forward." Revolutionary and progressive social changes promote the development of science and reactionary and backward social changes impede and disrupt science development.

In recent history the bourgeois revolution in Britain and France, the Civil War in the United States, Meiji Restoration in Japan and Xin Hai revolution in China are all bourgeois revolutions and have all defeated feudalism to a different extent and thereby promoted science and technology development in these countries. Modern science and technology is developed accompanied by bourgeois revolution and capitalistic production style.

The "May 4 Movement" in China unveiled the prelude to the new democratic revolution and raised the banners of "science" and "democracy," put forth "Mr S" and "Mr D," open war with ignorance and autocracy and played an active promotion role in China's scientific and technological development. The two big banners of the "May 4 Movement" are highly significant, science and democracy are twin

brothers, without democracy there is no science and without revolution there is no science. So the relationship between revolution, democracy and science is as follows.

Revolution ——→ Science

Democracy ——→ Science

Conversely, reationary social changes have great impeding and damaging effects on the development of science and technology. The modern history of China is sufficient proof. The disastrous effect of the Sino-Japanese War of 1894-95 awakened the Chinese people and a group of intellectuals vigorously advocated social changes. In the Wu Xu reform movement led by Emperior Guang Xu, China began to learn modern science and technology from the West. Although this was a reform movement, it also has social progress significance. But this reform movement encountered frenzied subversion by the gang of the empress, not only were the reformers beheaded, but all the advanced technologies were branded trickery in an encirclement and suppression, railroad tracks were torn down, loaded onto ships and thrown into the open sea, and science was feared like a plague.

The unprecedented "Cultural Revolution" conducted the greatest encirclement and suppression on science. Jiang Qing learned from the empress and went far beyond. She claimed "science is guilty," "the more knowledgable, the more reactionary," ignorance is "meritorious," "the more ignorant, the more progressive" and turning in a blank paper in exam is heroic." It can therefore be said that all counterrevolutionary social changes are antiscience. Authoritarianism can only produce ignorance and backwardness. Their relationships are:

Counterrevolutionary ——→ Antiscience

Authoritarianism ——→ Ignorance

FOOTNOTES

1. Qiu Renzong [6726 0088 1350], "Some Aspects of Western Science and Philosophy," 1979.

2. "Einstein's influence on my view of science--Interview with (Bopu), NATURAL SCIENCE PHILOSOPHY JOURNAL, 1980.3.

3. Bernard, "On the Road to Scienology," 1965.

4. Guan Shixu [7070 1102 4958], Jiang Zhenhuan [1203 2182 3883], and Wang Yan [3769 1484], "Science Revolution and Scientific Concept, 1980.7.

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IMPROVED SCIENCE RESEARCH MANAGEMENT ADVOCATED

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 1, Jan 82 p 1

[Article by Qian Sanqiang [6929 0005 1730]: "Establishing a Chinese Style Management Science Based on the Objective Rules of Science Research Management"*]

[Text] Along with the progress and development of modern science and technology, science research management emerged as a branch of science. At the present time some comrades have not recognized fully and understood the important role of science research management and some people even flatly deny the scientific nature of research management; so far there has not been a unified view on some of the theoretical concepts of science research management. Nevertheless, everyone is eagerly hoping to improve our science research management and promote the modernization of science and technology in China, this is a shared feeling. So how should be go about improving the standard of research management?

Basically speaking, the most important task is to explore seriously and study the objective laws of science management and advance from perception to theory and truly understand the "reasons" behind them. Then we need to apply them in actual practice and continuously make improvement. In the past we have repeatedly stressed "less interference, more attention" in management, that is, in our science research management we should follow scientific methods and do things according to the laws of science in order to promote scientific development and produce results and talents. In the past some people are accustomed to the "I'll tell you what to do" type of management, this situation should be thoroughly changed and management should be studied, employed and developed as a science.

To a larger degree the standard of research management depends on the quality of management cadres. Some of our comrades have engaged in science management for many years, they are enthusiastic about science and have done a lot of work on their respective posts and accumulated a wealth of experience, they made

*Excerpt from opening address given by Comrade Qian Sanqiang at the Chinese Academy of Sciences research management symposium on 17 August 1981.

many achievements in the history of building up the Chinese Academy of Sciences. But it should be realized that, along with the rapid development of modern science and technology, the requirement for research management is now increasingly high. It not only requires each management cadre to have the fundamental knowledge of a certain science discipline and be familiar with the characteristics and general rules of scientific and technological development, but also requires them to possess the knowledge and method of management science and be familiar with the policies of the party. The management cadres should also be good at organization and good at the use of theory to consolidate and improve work experience. Therefore, merely possessing general work experience and enthusiasm is far from adequate in meeting the demands of a constantly changing objective situation. Each of our science research management cadres must work hard to learn and to explore, constantly improving himself with new knowledge, reducing thoughtlessness and overcoming passiveness, and continue to contribute toward the management modernization of the Chinese Academy of Sciences.

Our research management should not only be characteristic of China but also be tied in to the actual situation of the academy. In the past few years we have gradually published considerable literature on foreign science management, this is a necessary step toward understanding the situation and broadening our viewpoint. However, our work and thought should not be limited by this literature and these concepts. The goal of our management science study is to solve our problems in China and the problem of our academy. Therefore we should neither adopt blindly the foreign experience nor should we reject them all. Whether we use them or not depends entirely on the actual situation. We should also advocate a spirit of innovation in research management. Only then can we solve the problems we are facing and propose our own theory and establish a Chinese style management science. I believe this is entirely achievable.

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TALK ON SCIENOLOGY, MANAGEMENT OF SCIENTIFIC RESEARCH

Beijing ZIRAN BIANZHENGFA TONGXUN [JOURNAL OF DIALECTICS OF NATURE] in Chinese, Vol 4 No 1, Feb 82 pp 39-44, 38

[Article* by Qian Sanqiang [6929 0005 1730]

[Text] The national Scienology Theory Discussion Conference is closing today. This conference has been a good one. Everyone has engaged in enthusiastic discussion surrounding the central subject of the characteristics of and the trends in the development of modern science and technology.

The main purpose of the academic discussion meeting is to exchange ideas and viewpoints fully, to give mutual inspiration, to improve together, and to promote the continued forward development of scientific research. Therefore, different academic viewpoints and advocacies of different schools that have emerged during the course of scientific research should follow the guiding principle of letting a hundred flowers bloom and letting a hundred schools of thought contend. We must not forcefully demand unification of different viewpoints. Everyone can bring these problems home to study and study again and then discuss them. I believe, if we do so, we will surely have an even better Third National Scienology Academic Discussion Conference, and we will surely be able to continue to improve the theoretical level of our nation's research in scienology.

My contact with the work of scienology happened 3 years ago. At the time, scienology research had just begun in our nation. Some comrades mobilized me to listen to people's concerns. As a result, I became more and more interested. I thought, I have returned for 33 years now, what have I accomplished? Wasn't it management of scientific research and the participation in decision-making and organizing leadership! For more than 30 years, my work basically belonged to the work of scienology. But at the time, the term "scienology" did not exist. The work was carried out blindly, and I was only an unconscious scienology worker (laughter). Therefore, there was a lot of blindness

*This is an excerpt from the speech by Comrade Qian Sanqiang on 11 October 1981, at the closing ceremony of the National Science of Science Theory Discussion Conference. This article was edited by Comrade Jiang Guohua [5592 0948 5478]--Editor's note.

in the work. We did not think of this in the past. As China's Scienology research developed bit by bit, it has now found its niche (laughter), which is the realm of scienology. Although I specialize in physics and scientific technology, in the overall view, my true area of activity is still more closely related to scienology.

Theoretical research in scienology must contribute to building China's socialist modernization. This is what the party expects from us, this is what the state expects from us, and this is what the people expect from us. It is not because the term "scienology" has emerged abroad that we have to study it. The reason we want to strengthen research in this aspect is solely to solve China's actual problems and to explore the laws of development of our nation's science, in other words, to contribute to the building of our nation's modernization. On the other hand, only by combining it with the actual situation in the development of our nation's science can theoretical research in scienology have a root, establish itself and be creative.

Today, in our nation's modernization, there are many topics that are closely related to scienology research, for example: the relationship between science and technology and economic and social development, the relationship between science and technology, the relationship among basic research, applied research and technical development, etc. I hope that comrades handle these relationships well in selecting research topics and in determining the direction of research.

Below, I will offer some opinions from the point of view of summarizing my personal experience and scientific research management as an unconscious scienology worker to serve as a reference for comrades. Please correct me on the points you find inappropriate.

(I) Strengthening Applied Research and Technological Development Are the Keys To Realizing Modernization of Industry

China is a large socialist nation and also a developing nation that emerged from a semifeudal and semicolonial society without going through the stage of development of a capitalist society. Starting from Dr Sun Yat-sen and tracing backwards to the first half of the 19th century, progressive elements all wanted to begin working hard for the prosperity of the country, even though it was much later than Japan's Meiji Restoration. But because of many reasons, up to now, there is still a big gap between us and Japan in economic development and in science and technology. The government of the Manchu dynasty, especially during its later years, was very corrupt internally. Headed by the Empress Dowager, not even the opinions of the reformers were accepted, therefore, the situation forced the occurrence of the revolution of 1911. Our nation's history was different from that of Japan and also different from that of European nations.

Europe was the origin of modern natural science, or more precisely, natural science that expressed laws and relationships in quantities began in Europe. At the time, the creators included Galileo and others. Before this, or about 400 years ago, Europe was not more advanced than us. The many facts recorded

in the book "A History of Chinese Science and Technology" by British scholar Joseph Lee fully proved this point. But since the Renaissance, the gap gradually widened. The Renaissance was the germination of European capitalist culture and ideology. It was the product of the newborn capitalist production releations. It advocated humanism and opposed the feudal-religious thought centered around God. For example, Italians represented by Galileo freed themselves from many restrictions and achieved a high degree of personal development, and with the influence of the tradition of Greek culture, their thoughts turned to the discovery of the external world, and these were expressed in written descriptions and in mathematical relations of observed data. They manufactured things and developed things, and bit by bit, they formed a scientific research based mainly on the modern consciousness of observing phenomena. Finally, these were summarized in mathematical or logical and deductive scientific laws. Among the comrades here today, there are those who have studied physics in middle school. The most difficult concepts to understand when first studying physics are in the first chapter on mechanics. The most difficult concept in mechanics is acceleration. In ordinary life experiences, they are only forces and speed, and establishing the concept of acceleration is not easy at all. It was founded after many years of observation and study by Galileo. It was on the basis of astronomical observations, experiments and research by scientists of the generations before and after Galileo that Newton was able to finally summarize the findings into the famous "Newton's three laws of motion" and the "law of gravity" which in turn established a firm foundation for the various branches of science, engineering and technology. Later, the advent of the capitalist Industrial Revolution enabled capitalists to use natural science as a means to pursue wealth and riches. Science thus possessed the historical condition for a large-scale transformation directly into a productive force. From then on, a new era of a close combination between science and industry began. Science entered the realm of material production on a large scale, and this greatly improved the productive forces of the capitalist society. Conversely, the development of productive forces of the capitalist society also greatly hastened the historical progress of socialization of scientific labor. Therefore, I often said the emphasis of capitalist nations on science and technology has a long history of development as background for understanding. They have formed such a tradition. No matter how ignorant a capitalist is, at the end, he will learn to rely on scientific and technical experts. This is because without scientists, engineers, and skilled technical workers, and without carrying out industrial and scientific research and developmental studies, his products will lose their competitiveness and money will not be earned. Therefore, it is not that capitalists especially like scientific and technical experts, it is the result of the importance of "money" in the eyes of the capitalists. Holland, for example, utilized the achievements in the study of optics to push forward the development of the eyeglass manufacturing industry. We must realize that that was during the middle of the 17th century. At the time, manufacturing eyeglasses was as attractive as today's manufacturing of tape recorders. Many old people who could not see could solve the problem by wearing a pair of glasses. This produced a social effect. As a result, the capitalists became rich and at the same time optics developed in a more rapid way.

In recent times, the relationship between industrial development and scientific research became even closer. For example, everyone knows that German products are ingenious and sturdy and Japanese "Toyota" cars are sold everywhere but the German "Mercedes-Benz" is also widely used. This is because Germany has its historical tradition and a tradition of emphasizing applied research and developmental research in industrial development.

According to recollections of comrades who had worked in the materials research laboratory of Germany's Siemens Company at the beginning of the 1940's, Siemens' electric current meter that was sensitive to weak current was sold throughout the world. The key was the materials research laboratory at Siemens which developed high quality materials for each part of the current meter. The materials laboratory at the time, if described by today's classification of specialization, could be described as an entity combining the science of metallurgy, the science of metals, solid state physics, and material mechanics. The problems of technology and techniques proposed in production were all brought to the laboratory to be solved. According to these comrades, this was not only so at Siemens, almost all major German companies had a corresponding industrial research laboratory. This may be one important reason German industry has always remained in the leading position in the world. For example, America's Bell Telephone Company laboratories are also world famous. They have many scientists as talented as Langmuir. Most of the laboratories of American universities allow visitors, but the Bell Laboratories generally do not allow visitors. Their work is often several years ahead of present production needs. It is said that some companies are again advertising in the newspaper to hire researchers in the theory of particle physics at high salaries. This obviously is not for present needs.

They are preparing for several years later to use the research methods used in particle theory. They have such farsightedness and they want to make definite preparations in particle theory to explore new roads for future development. The purpose of mentioning this is to explain that after World War II, American capitalists have paid more and more attention to scientific research. At many places, small factories and small designing offices are established right next to universities to attract and to make it convenient for university professors and teachers to concurrently engage in applied research and development research.

Take Japan as an example. The universally accepted view is that Japan's industrial sector pays a lot of attention to applied sciences, applied research and technological development. When we were young, we looked down on Japanese goods. We said that Japanese goods were of poor quality and they broke soon after use. Yet Japanese products are now very different after 30 to 40 years of efforts. Japan may have relied on developing science and technology because of its natural historical conditions of having a small national territory, scarce resources, and a large population. Otherwise, its products would not have entered the world market, and it would not have been able to compete with developed nations. Therefore, it engages in more applications type scientific research. Of course, Japan's emphasis on scientific research did not begin after World War II. At the time, there was a magnetism expert who went to Germany to study. After he returned, he first began establishing

a metallurgical research institute. It was this research institute that formed the scientific and technical foundation for the later development of Japan's iron and steel industry. Many things, basic research and developmental research, technological processes and scientific technologies all came from this research institute. Therefore, today's industrial development in Japan is inseparable from this generation of old scientists who began emphasizing applied research and developmental research. Japan pays a lot of attention to basic sciences, therefore it has produced such remarkable scientists as Yugawa Hideki.

Generally speaking, capitalist nations all have a tradition of scientific research which started out for their benefit during its course of development. In industrial development, more emphasis is placed on the achievements of applied science and technology, and more emphasis is placed on applied research and development research that are suitable to and needed by the industries themselves.

In contrast, we lack actual understanding of the important function of science and technology in promoting national economic development. We do not have sufficient understanding of the importance of scientific research work in the industrial departments, and we have not truly placed it at the position it should enjoy. At the beginning of the 1950's, our nation accepted a group of projects with assistance from the Soviet Union. This has exerted a very important influence on our nation which now has a major industrial contribution. This should be fully affirmed. Now it seems that there are also some lessons which are worth summarizing. This, we did not fully understand the technological principles of some of these projects. Later, corresponding industrial applied research and developmental research did not follow up. As a result, you can build a factory and it can operate but when necessary, you can also investigate and copy, but, you will not be able to establish a creative ability. Without a creative ability, we will not be able to compete against others internationally. Therefore, since liberation, we have realized great achievements on the one hand, especially in the industrial sector. Its relatively important basic industries have already formed a complete system, but on the other hand, there are also deficiencies. nhat is, some industrial departments did not pay as much attention to applied research and developmental research as they should have, and they did not form the ability to carry out industrial and scientific research to promote the continued development of our nation's industry. Not possessing a strong ability to carry out industrial and scientific research is a major hindrance to our progress in modernization at present. This lesson is one which we should remember well.

Practice proves that in some industrial and scientific research, first of all, applied research and developmental research in basic industries is very important. This is the key to our nation's industrial modernization. Otherwise, the whole industry will not have the ability to climb slopes. It will lack self-reliance and the ability to establish itself as one of the world's advanced industries. Thus, we must overcome the obstacle posed by the idea of simply relying on imports without digestion and specifically copying others. We must also change the irrational way of providing funds only for importing equipment without providing funds needed to digest and improve the equipment.

Vice Chairman Deng pointed out in his talk at the science conference that the key to the four modernizations is scientific and technological modernization. This is right. I hope our industrial departments are determined to carry out effective and helpful measures to strengthen and improve the scientific research ability of our nation's industries.

(II) Whether It Is Basic Research or Applied Research, Both Must Be Strengthened

Recently, many people are again discussing the problem of planning our nation's scientific research. Some say that too much capital is being invested in basic research and it should be reduced. Others say that we are overly emphasizing applied research and this should be lessened. In fact, the two views are unilateral. In my view, whether it is basic research or applied research, we still cannot say that the investment is too much now. The investment is not enough. Some localities have invested far from enough. Therefore, I believe there should not be any debate and accusation. We should in turn strengthen organization, supplement each other, make overall arrangements, and develop them together. Of course, I am not saying that problems of imbalance in planning or distribution do not exist. This should be noted in actual work.

Everyone knows that what we call science is the system of knowledge about nature, society and thought. Studies in the history of science show that science originated from human production and actual needs in living. Its history is as long as man's own evolution. Therefore, science, especially natural science, by nature, is the knowledge of man's understanding of nature and man's efforts to rebuild nature. Basic scientific research is the leading edge of man's understanding of the objective laws of nature and also the starting point of exploring new technological areas. It can be easily seen that basic science is the cornerstone of modern scientific structure. Basic scientific research is the "generator" that discovers and invents ideas of modern science. The Swedish physical chemist Svante August Arrhenius said "Theory is the most important driving force in the realm of scientific knowledge,...theoretical research can point out in which direction the work should be guided in the future in order to realize the greatest achievement."[1] This is very true. In my personal experience, I realize that our nation's success in building the atomic bomb and the hydrogen bomb was truly inseparable from our early grasp of basic scientific research in theoretical physics.

In the spring of 1980, at the particle physics theoretical discussion conference held in Guangzhou, many Chinese-born scientists allowed us to talk about the development of science since the founding of new China. Their questions were very straight forward. They asked, was your first atomic bomb designed by the Russians? We said, no. The Russians did not design it, nor did the Jews, it was designed by ourselves. After the comment, they all laughed. Because the first American atomic bomb was developed with the participation of many Jews, and the hydrogen bomb was developed under the leadership of a

1 "Journal of Chemistry," St. Petersburg (1907), Russian Edition, p 111.

Hungarian Jew, Edward Teller. But we Chinese developed the atomic bomb ourselves. In the 1950's, a Soviet adviser came and said he would help us develop atomic energy, but he never said anything. We called him the "dumb monk." At the time, the design institute built for us was not like the ones in their own country, surrounded by many research laboratories and experimental laboratories. They began by saying we should build very beautiful buildings to let you make drawings inside. What was the basis for making the drawings? At the time, we had a figurative saying to describe the situation: The brain is in Moscow and the hands are in Beijing. The design institute became Moscow's hands extending to Beijing. If the brain did not give commands, the hands had to stop work. We pointed out at the time, should we build some peripheral experimental laboratories and research laboratories. He said they were not necessary. When you have the need, you can stand on our shoulders and climb up! This was such a smart saying! How easy it is to climb up on someone else's shoulders! But when this someone moves his shoulders away, you will not have anything to hold onto and you will fall down. Historical facts proved that this was the outcome. I repeat this history today to show that the nation's major scientific research and engineering projects must all have our own research foundation. Relying on others will never be reliable.

Everyone knows our nation's science and technology are still very backward in many realms. But cadres in theoretical physics, especially cadres in atomic energy theory, were trained by ourselves after liberation and under the party's leadership. They have victoriously completed the tasks handed to them by the higher authority and have contributed to the state. Several years ago I went to France. They thought it was a great feat for our country to develop the atomic bomb and the hydrogen bomb ourselves. They said, France developed its first atomic bomb earlier than China, but China developed its first hydrogen bomb before France. France developed its hydrogen bomb more than 7 years after it developed its first atomic bomb. We used only 2 years and 8 months. What was the reason? The Frenchmen of course had an estimate. We relied on our own strength and we were able to develop the hydrogen bomb only 2 years and 8 months after our first atomic bomb. Besides the party's correct leadership, I should say, our scientists grasped theoretical research in physics early and made the necessary scientific preparation. ehis was very important. In the viewpoint of the science of science, this coincides with scientific and strategic decision. It also coincides with the general laws of the science of science studied by comrades attending this conference, even though the term science of science did not exist at the time. Of course, we emphasize paying attention to basic research. This does not mean that it should share half the effort with applied research (including developmental research). According to the situation in industrially advanced nations and our own historical experience, basic research, when compared to applied research, does not occupy a large proportion in the distribution of scientific efforts. Take the atomic energy work begun in the 1950's after liberation as an example. Research in theoretical physics constituted about 5 percent while applied research and experimental research constituted over 90 percent. At the time, those engaged in theory started out in a small office inside a one-story house in a four-unit compound and courtyard. But because this 5 percent of the basic theoretical research team always remained active and continued to work,

to work after we successfully detonated the first atomic bomb, we were able to quickly enter the development of the hydrogen bomb, and we quickly achieved success. We were faster than France maybe because we saw further into the future than others in devising scientific tactics. Therefore, we should not neglect basic scientific research.

If we take scientific research as a whole, considering it in the overall situation of the whole nation's provinces, cities, higher educational institutions, industrial departments, national defense departments and the science academies, then, we should say, applied scientific research in our nation is far from enough. For example, in the provinces and cities, the most important is to carry out more applied research, especially applied research that combines with the needs of the provinces and cities. We cannot allow almost every province and city to engage in particle physics research just because a national particle physics theory discussion conference was held. Within the whole nation, we can have some comrades at several universities engaged in such research, but as a province or city, applied science that is most closely related to the locality and the national economy and that is the most urgent and the most important should be grasped. In some developed or partially developed industrial nations, there are many such cases. For example, in Australia, the problems with cattle dung and the "rabbit disaster" were solved locally by cooperative efforts between biological workers and medical workers. As a result, the development of agriculture and livestock production was greatly accelerated. In the 1950's, we successfully controlled locust in the Weishanhu area. This is also a very good proof. Before liberation, we would hear of locust disasters every 2 or 3 years. The locust covered the sky and consumed large expanses of food grains. After liberation and under the leadership of the party, our nation's biological workers and local scientific workers in various disciplines cooperated and learned the place of origin of the locust and its living habits, and they created a method to control and destroy it. During the last 3 to 5 years, locust damage has been basically eradicated. Such applied research work should be specially noted by local scientific research comrades. Similarly, industrial departments should emphasize industrial applied research related to their own industries. Agricultural departments should emphasize applied research in agriculture. The universities, I believe, should engage in both basic research and applied research. In the past, our universities emphasized education and paid insufficient attention to scientific research. I believe, first, scientific research in the university should be applied research to study problems related to and brought out by industrial and agricultural production in the province and city where the university is located. Second, scientific research in the university should be to appropriately develop exploratory basic research. With the addition of the Chinese Academy of Sciences, and according to the concrete situation of the distribution of scientific research efforts throughout the nation, according to the principle of "emphasizing the basics, emphasizing improvement, to serve the national economy and national defense buildup," and according to the spirit of strengthening the function of the Chinese Academy of Sciences in promoting the development of the national economy, the universities should readjust their scientific research tasks. In this way, I believe our whole nation, as an overall entity of scientific endeavor, can organically combine

basic research and applied research. The glorious task of our nation's four modernizations has a bright future.

An ancient Chinese saying said it well. All things can be done if prepared for, all things not prepared for will be a waste. If we want to realize scientific and technical modernization, we should analyze the overall situation of our nation's scientific endeavor now. We cannot repeat what others say. Chairman Mao said: "Analyzing a situation well is very beneficial." Now, the actual situation of our nation's scientific endeavor is that basic research, applied research, developmental research, or product research all need to be strengthened. Many of the comrades here today are theorists in the science of science and in management science. I hope that you will bring this point back to the localities and propagate this point throughout the nation and ask the leaders at each level to pay attention to this point. We are a socialist nation and also a big nation. As long as the leaders at each level understand this and conscientiously grasp this, then the victory of scientific and technical modernization will be firmly won.

(III) Party Leadership and a Good Scholastic Style Are the Fundamental Guarantees of Scientific and Technical Modernization

I have returned for more than 30 years, and I have always been involved in the organization and management of science and technology. Although some achievements have been made and some experience has been accumulated, many mistakes have been made, and I should admit that scientific research management to me is still a necessary kingdom that has not been completely understood.

As some comrades pointed out in research, a fundamental principle of the science of science is to manage science according to the characteristics of scientific research and our nation's characteristics. In my personal experience, the key to realizing scientific and technical modernization is to insist on party leadership. There must be a scientific research team with liberated ideology, with a spirit of creativity and a good scholastic style. In remembering the years 1953 and 1954, I realize that because the party's leadership was correct, because there was a relatively uniform group of leaders, and because the major leading comrades were enthusiastic about science, the leading comrades held an attitude of allowing scientific research personnel to have a free hand. Everyone felt comfortable. The situation was stable and united. Everyone wholeheartedly engaged in scientific research, and everyone contributed their talent. Therefore, party leadership and good cadres will fully mobilize the socialist enthusiasm of scientific and technical personnel. When they show shortcomings and make mistakes, they must be criticized and helped, but we must always do as Chairman Mao said: "To learn from past mistakes to avoid future ones, and cure the sickness to save the patient." We must start out from the point of view of cherishing them, because the purpose of criticism and help is still to let them develop a greater function in scientific research work.

In addition, scientific research personnel must be Red and expert, and they must consider this a working characteristic in scientific research. They cannot simply pursue form. They cannot be demanded to attend meetings here

today and give speeches there tomorrow. Some people do not like to speak but they work well.

At the particle physics theory discussion conference in Guangzhou in January 1980, many Chinese-born scientists unanimously believed that the most important aspect in scientific work is creativity when they talked about scholastic style. In a certain sense, without creativity there is no science. Creativity is the soul of scientific research. Creativity is the core and the quintessence of a nation's scientific capabilities. Therefore, we must insist on party leadership, carry out political ideological work, create a lively and active working environment for scientific research personnel and make it easy for them to fully develop and manifest their creative intellect.

Of course, the formation of a good scientific scholastic style similarly relies on the democratization of the academic environment. Everyone knows the key to science is talent. The world history of science shows that the growth and training of large numbers of able scientific and technical talent and even outstanding scientists are possible only in a profoundly academic environment. The training of talent at present in our nation is to develop fully the function of middle-aged and young scientists under the guidance of older generation scientists. They are now the backbone and hard core of our nation's scientific research. Therefore, on the one hand, we must advocate liberating ideology, and we must especially advocate that middle-aged and young scientific workers develop the spirit of creativity which young people possess, and on the other hand, we must advocate academic democracy, correctly treat creative academic thought, and avoid the suppression of new born forces which has occurred several times in the history of science. I believe that such people can be found at any time among people of any nation. They begin with a shallow foundation of knowledge, but they work hard, they do not fear authority, they are driven by an irresistable force and advance along the road of scientific research. And very outstanding achievements can be made only because of their hard work. But when they learn more and when they have acquired a special skill in a certain field, and when they become an authority within a definite period, they frequently become what some comrades had just mentioned, a person whose body of knowledge rejects or hinders the development of new knowledge. New-born things are thus in danger of being suppressed or discouraged. In the recent history of physics, a relatively famous case was the rejection of the young Danish physicist Bohr by J. J. Thomson. Everyone knows J. J. Thomson was a British physicist. He conducted a lot of vacuum discharge experiments and proved the existence of the electron. In 1897, he determined the electron charge to mass ratio in the study of cathode rays (electron charge e/mass m), thus he discovered the existence of the electron by experiment. At the time, the center of experimental physics was indeed in Britain at the Cavendish Laboratory at Cambridge, and the leader of this laboratory was J. J. Thomson. Although a generation of outstanding physicists were trained under Thomson, but, as a Chinese ancient saying said it well, "an intellectual has a thousand worries, and he will make a mistake." Because he made a lot of achievements in the study of the electron, and because electrons exist in every atom, therefore, in his mind, the electron should occupy the central position in the atom. His most brilliant student, Rutherford, held a different view of the atomic structure. Later, young Bohr

came to Thomson and talked about his idea of the model of the atom. Thomson heard him but did not believe him, and refused to accept Bohr to work there. Later, Bohr found Rutherford. At the time, Rutherford had left Cambridge. They had similar views on the structure of the atom. Rutherford asked Bohr to work with him, and not long afterwards, they finally created the Rutherford-Bohr model of the atom. This was the model of the atom with the atomic nucleus at the center surrounded on the outside by several circling electrons which we now use. Bohr later became a world famous first rank physicist. It was rumored that on J. J. Thomson's 70th birthday, he said regretfully that his greatest regret in his life was not to have accepted Bohr as his student. This story shows that when a person acquires a lot of knowledge and when he has a lot of authority, sometimes he will not easily accept new things. Such cases have frequently occurred in the history of science. Before a person becomes well known, he is frequently suppressed by other authority, but when he becomes famous, he may similarly suppress others. To say that he is devious is not necessarily true, but such facts indeed exist. Therefore, besides insisting on party leadership, we must greatly advocate a good scientific scholastic style. A good scholastic style is like a good work style, it is a shapeless force, and it can push forward and promote our nation's scientific endeavors to help develop healthily along the correct road.

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UPGRADING S&T MANAGEMENT BY QUANTITATIVE EVALUATION METHOD

Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese No 5, 20 Oct 81, pp 24-26

[Article by Zhang Yihong [1728 0001 3414] of the Gansu Computer Center: "A General Quantitative Appraisal of the Societal Functions of Computer Centers"]

[Text] In the routine management of science and technology, it is necessary to make frequent evaluation of multifunctional technical departments geared toward societal service such as computer centers in order to analyze, determine, compare and appraise the performance of societal service and the contribution of these departments in a given period or in different periods of time so that comparisons can be made as objectively and accurately as possible.

The actual situation, however, is often relatively complex. In order to make a general evaluation, one must first divide the overall performance of the target under evaluation into a number of categories. Some of these categories may be qualitative performance and others may be quantitative. How should the evaluation results be integrated scientifically? Within the category of quantitative performance, the measurement units of various quotas are not always the same, so how should the computation be conducted uniformly? Different departments participating in the evaluation or the same department in different periods of time may provide a different number of services to the society, so how should the comparisons be made? And so on.

In order to solve this problem, we propose the following general quantitative evaluation method based on our study and investigation of scientific ability and wish to share our work with other investigations. The heart of this method is as follows: by establishing a mathematical model known as the performance index appraisal equation and with the aid of a simple calculation of a few single-item statistical indicators, a general performance index K can be found which is then used as the only quantity for comparison or measurement in the general appraisal.

We believe that investigations made with this model will provide some assistance in improving our S&T management standard and efficiency.

I. Parameters Considered in Appraisal Equation

In general, the contribution of a computer center to society or the performance of its societal function depends on the conditions of the surrounding environment and the need for a computer center. For the sake of simplicity, the effect of external environmental factors do not appear directly in the model; instead, they are taken into account when specific single parameters are determined.

In the investigation of the societal functions of an open public computer center, it is realized that this type of department should provide multi-functional technical services to the society, including offering machine time, software reprocessing, data storage service, organizing academic research on the development of computer applications, application promotion, popularization publicity, organizing technical information exchange activities using the computer, maintenance and repair service, and application of coordinated management.

Here we propose function parameters in eight different areas as the external variables of the model, and further divide them into four modules according to their role and status:

1. Equipment condition M:

M is a function of machine time parameter Y, software function parameter S_1 and data storage function parameter S_2.

$M = f(Y, S_1, S_2)$

2. Knowledge and intelligence N:

N is a function of information signal utilization parameter X, technical personnel structure function parameter T_1 and publicity and popularization function parameter T_2,

$N = g(X, T_1, T_2)$

3. Supplement V:

V represents other added noncentral service items.

4. Policy management G:

G represents the function parameter of management policy and external coordination.

Modules (1), (2) and (3) above belong to basic function and module (4) belongs to the high-level "amplification" stage.

II. Mathematical Model of Appraisal Equation

Let K be the function index of a computing time for a certain time interval representing the service function of the computer center to the society, then

$$K = G[Y\ (aS_1 + \beta S_2) + X\ (\gamma T_1 + \delta T_2) + \varepsilon V^2] \text{..........(i)}$$

Suppose

$$M = Y\ (aS_1 + \beta S_2) \text{..........(ii)}$$

$$N = X\ (\gamma T_1 + \delta T_2) \text{.........(iii)}$$

$$P = \varepsilon V^2 \text{..................(iv)}$$

then equation (i) may also be rewritten as

$$K = G\ (M + N + P) \text{..........(v)}$$

In equation (i) the coefficients α, β, γ, δ and ε are all non-negative and in general not equal to 0. The sum $a + \beta + \gamma + \delta + \varepsilon = 1$ is called the weighting coefficient. We shall call equation (i) or equation (v) the appraisal equation of the computer center function index.

III. Determination of Function Parameters and Weighting Coefficient

1. Function parameters.

Based on the statistical method of specifying a series of single item evaluation criteria and indexes, we may assign the group of parameters, G, Y, S_1, S_2, X, T_1, T_2, and V specific values and take them to be parameters corresponding to the evaluation standard.

For example, in the determination of the machine time utilization parameter Y, we may specify the following "machine time unit" as an index for evaluation measurement:

(machine time unit) + (200,000 times/sec x 0.5 kilobyte internal storage x 1 operating user terminal x 1 hour of running time)

According to this scheme, a computer with a speed of 500,000 operations/sec and an internal storage of 1 kilobyte will provide 100 "machine time units" when five users used the machine simultaneously for 4 hours.

We may represent the magnitude of Y by the number of "machine time units" actually provided by a certain computer center during a given time period (a certain year or month). When several computer centers are being compared, one may use the number of "machine time units" of a certain computer center (considered to be an evaluation standard) as the base and set its Y value equal to 10, say, and then compare the number of "machine time units" of other computer centers to this base value and determine their Y values (a specific number greater than, equal to, or less than 10). When the performance of the same

computer center during different time periods is being compared, the same method may be used in determining Y.

In a similar fashion we can also specify the statistical values of the evaluation criteria and index for parameters G, S_1, S_2, X, T_1, T_2 and V. For certain qualitative items we may adopt an "ambiguous scoring method" and assign some quantitative values to these items according to the degree.

2. Determination of the weighting coefficients.

Weighting coefficients reflect the degree of influence of various parameters on the results of general appraisal. Their values may be determined by the leadership organization based on the statistical analysis of previous data, using relevant policies and regulations as a reference. For example,

$a = 0.3, \beta = 0.2, \gamma = 0.5, \delta = 0.2, \varepsilon = 0.05,$

Weighting coefficients may be frequently adjusted according to shifts in policy emphasis.

IV. Applying the Appraisal Equation

First of all, statistical data and signal information for different time periods of all computer centers participating in the evaluation should be prepared and ready. Assuming that we have specified the statistical method for the indexes and the evaluation criteria for the function parameters, and the leadership has ordered the distribution of weighting coefficient values (or assigned before the appraisal), then we are ready to use the appraisal equation in conducting horizontal and vertical comprehensive appraisal.

1. Vertical appraisal.

When appraising the function index changes of a given unit for different time periods, a certain time period (must be a period of normal operation) may be arbitrarily chosen as the basis for appraisal, and all function parameters in this period taken to be 10, then the function index for this period is K = 1000. The item indexes in various time periods to be evaluated can be compared with those in the base time period and the values computed for the various function parameters in all the time periods (they may be greater than, equal to, or less than 10). Substituting these values into Equation (i), the function index value K can be calculated for the time periods. For example, $K_1 = 980$, $K_2 = 1150$, $K_3 = 1349$,.... Quantitative appraisal can then be conducted for the different periods of time.

2. Horizontal appraisal.

When the function of different units in the same time period are compared, one unit may be arbitrarily chosen as the standard for appraisal, and its function can be $K_o = 1000$. Using a comparison calculation method similar to the above, individual item function parameters are first calculated, then, using Equation (i), function index K values of various computing center are computed, e.g.,

$K_A = 1086$, $K_B = 1549$, $K_C = 798, \ldots$. Comparison appraisal can then be carried for different units.

It is clear that the values of various function parameters only have relative significance and that they are dimensionless quantities. Weighted operations can be made and the comparability is independent of the choice of appraisal standard.

V. Additional Remarks

1. As can be seen from Equation (v), the definition of the function parameters and the division of modules are universal. A technology can always be divided into hardware and software, and management is an "amplification" of the technical ability (the amplification factor may be greater than, equal to, or less than 1). If the management is in shambles and the policy decision full of errors, then no matter how great the technical force, it cannot play its role. Particularly, when $G = 0$ and $K = 0$, nothing can be achieved.

2. The supplemental module $P = eV^2$ is not the main mission of a unit and has little effect on the appraisal results. For this reason, a relatively small weighting coefficient e is used to attenuate its effect.

3. Using the appraisal equation as a mathematical model, one can clearly see the division of computer application organizations. This is valid even for some special cases.

(1) When $Y = 0$ or $S_1 = S2 = 0$, we have $M = 0$. When no machine is available, the organization may be a computer technology workshop. In this case

$$K = G[Y\ (\gamma T_1 + \vartheta T_2) + \varepsilon V^2]$$

(2) When $M \neq 0$ but $N = P = 0$, the machine is available but research and promotion personnel are not. This would be strictly a computer room.

(3) When $P \neq 0$ but $M = N = 0$, the unit will be strictly a maintenance service station.

(4) Equation (i) can also be used in planning design or prediction analysis for the mode of development of a computing center. It provides some basis for decisionmaking. This method may be generalized to appraise not only similar department such as analysis and testing centers and information centers, but also the teaching and research abilities of higher educational institutes and the ability to treat and prevent disease of medical units, using the same method but redefining the meaning of various function parameters without losing generality.

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BRINGING SCIENTISTS AND SCIENTIFIC SPECIALISTS INTO POLICY-MAKING PROCESS

Taijin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese No 5, 20 Oct 81 pp 2-6

[Article by Xia Yulong [1115 4416 7893], Liu Ji [0491 0679], Feng Zhijun [7458 0037 3182] and Zhang Nianchun [1728 1819 2797] of the Shanghai Scienology Institute: "Leaders in Science Policy-making"]

[Text] The empirical policy-making with regard to small production, it is entirely up to the leader. The process of modernization construction is a process of transforming small production of to socialized large-scale production, and the policy-making must be made more scientific. What role should a leader play in science policy-making? How should this role be played? What aptitudes are required to play this role? All these are questions worthy of serious exploration.

I. Leaders and Scientists

So-called science policy-making is making decisions based on a sound scientific process, relying on scientists, and using modern methods and advanced techniques. Hence, in the process of science policy-making, the leaders and the scientists are two forces that should complement each other and there should not be a preference toward either. The correct handling of the relationship between them and development of their respective functions in decision-making is the key to science policy-making. On this basis, a leader must have sufficient understanding of the following three items:

1. The work of scientific specialists is an indispensable factor in science policy-making because:

(1) Each leader is a policy-maker with regard to the next lower level and an implementer with regard to the next higher level, so he has a lot of routine work to go through and it is impossible for him to conduct an in-depth analysis on each and every policy matter.

(2) Although many leaders are knowledgable and competent people, they cannot possess and explore a series of methods and techniques in science and policy-making. This is the specialty of scientists and experts.

(3) No matter how wise and thorough, one always misses something. The all-knowing and always correct leader simply does not exist in reality. Being in a high position, a leader must listen to the opinions of experts with an open mind in order to prevent or reduce policy errors.

2. The job of scientific experts is to assist the leadership in making policy and not to make decisions for the leadership because:

(1) Although quantification is an important factor in science policy-making, in practice a policy decision often contains some aspects that cannot be quantified or compared. For example, there is no common quantified comparison indicator for investment returns in industrial and culture departments. Besides, things are on different levels in the world; some things can be totally understood and described precisely in mathematical terms, some things can be explained clearly but cannot be described mathematically, other things can be sensed but not described verbally, and there are still other things that cannot be completely comprehended for the time being. All of these may require policy decisions. A specialist deals primarily in quantifiable work, computes the cost and benefit of various factors and the total cost and benefit of various proposal combinations, and works out the order of merit to provide the leaders with a scientific basis for policy decisions. The real key in policy-making lies in the value judgment regarding those aspects that cannot be compared directly; this is the leader's job and it also shows the level of his decision-making.

(2) The thought pattern and the scientific method and technique of a scientist are often based on ideal conditions; a policy decision, however, must put things into practical action. Understanding of a complex situation in action and utilizing various adaptive techniques are precisely the requisites of a proficient leader in a position of having an overall view.

3. The following three problems should be given proper attention in developing the role of scientists and specialists in decision-making:

(1) Let the specialists carry out their independent research. In any policy decision, experts must be allowed to draw their own scientific conclusion based on the objective situation in order to benefit the policy-making. The leaders should never be allowed to draw the conclusion first and then let the experts investigate the "facts" and invoke the "scientific principles" to "prove" the correctness of this conclusion. This type of decision-making, although it has the appearance of being backed by expert opinion, is actually fooling oneself.

The famous American management scholar Drucker was hired in 1944 by General Motors as a management policy consultant. On his first day at work, the company president, Sloan, told him: "I don't know what we want you to study or to write and I don't know what results you should obtain. These are all up to you. The only request I have is that you write down whatever you think is correct. You do not have to worry about our reaction or be afraid of our objection. Most important, you do not need to accommodate or compromise to make your proposals acceptable to us. Everyone in our company knows how to

accommodate and compromise, and we do not need your help on that. Of course you can accommodate and compromise, but you must first tell us what is correct so we can make the correct accommodation and compromise." These words of Sloan, who is praised in Western management fields as a "genius of modern organization," are worthwhile for the leaders and experts to think over.

(2) Let the experts play an adversary role. The nature of a brain trust which assists the policy decision is entirely different from that of a secretariat. The job of a secretariat is to comprehend and carry out the leader's intentions and it is judged by the accuracy of its comprehension and the thoroughness of its execution. The brain trust serves the policy maker with the results of its independent scientific research and it is judged basically by how much real knowledge and how many brilliant ideas it can come up with. Without different views and the courage to speak up, a brain trust will no longer be a brain trust. Whether or not accepted by the superior, the opinions and suggestions of the brain trust have positive significance; at least, it lets the leader hear both sides. We believe that if one-third of the suggestions of a think tank or a brain trust are followed, it is above average. If more than half of the recommendations are adopted, that is outstanding. But if 100 percent of the opinions are accepted, it indicates that either the scientists are exceeding their duty or the leadership is incapable, and this is very dangerous to policy-making.

(3) Do not be swayed by the experts. A leader must always remember that he is the one who makes the decisions. Scientists are also members of society and they are of various qualities; some do not hesitate to speak their minds and some like to go along with the leader's intention. Even among those who are not afraid to speak out, some of their opinions are correct and some are not. Thus, a leader that completely relies on experts is essentially neglecting his duty.

The best way to prevent being swayed by experts is to listen to the opinions of various specialists. One can make a judgment only by comparison. Do not be afraid of too many opinions, the key is for the leader to judge the opinions strictly on their merits, regardless of how close or prestigious the expert is. Furthermore, one should pay attention to an expert who is not afraid to speak the truth, especially if his candid opinion was rejected earlier and later proven to be correct. Otherwise, the capable people will stay away and one will be surrounded by narrow-minded people. Comrade Chen Yun [7115 0061] once said: "If you are constantly hailed by the people, any mistake you make will be a grave one." Policy-makers should take this as a motto.

II. How Can a Leader Make Scientific Decisions?

When the experts come up with a policy proposal based on scientific procedure and submit it to the leader, how should the leader contemplate, investigate and make a decision in a scientific manner? We believe that attention should be concentrated on the following four areas:

1. Investigate whether the proposal is consistent with the predetermined policy goal and value standard.

The policy goal is the predominant essential; if a proposal deviates from the policy goal or is irrelevant to the policy goal, then it is undesirable no matter how sophisticated the policy-making technique and mathematical method used in the proposal.

In evaluating the value of a proposal, one should primarily weigh those aspects that cannot be compared directly. Among the incomparable aspects, the only judgment factor is value. In general, there are three values--academic value, economic value and social value--and they should be treated without preference. Ordinarily there are social objective evaluations of all three values, and leaders should have a thorough understanding of them. But societal evaluations vary; a leader must have his own opinion and combine it with the societal evaluation so that he can achieve a certain effective balance between substances that cannot be directly compared.

One important aspect in weighing a policy decision is the principle of interest. There are only three situations: the first one is with advantages and without disadvantages, the second situation is with both advantages and disadvantages, and the last situation is with disadvantages and without advantages. Regarding the second situation, there are cases in which the advantages outweigh the disadvantages, the advantages and disadvantages are equal, or the disadvantages outweigh the advantages. Regarding the third situation there is also the difference of different degrees of disadvantage. In contemplating a policy decision, the case of advantages overwhelming disadvantages is naturally desirable, but in some real situations one would do well to opt for the least adverse condition. For example, because of a wrong policy decision in the beginning or because of a drastic change in circumstances, a certain engineering project has very little hope of continuing; then, although investments are already made, one should make a firm decision to call off the project in order to avoid further loss. There are often times when we have to take a small loss to make a greater gain; doing business below cost in order to occupy a corner of the market is one example. In short, a leadership that is always unilaterally hoping for the maximum gain regardless of the circumstances does not necessarily make good policy decisions.

2. Different types of policy decisions require different kinds of thinking.

As is well known, according to the nature of the goal, there are definite and indefinite policy-making (also known as regular and irregular policy-making. When a leader evaluates the research report of experts and makes the final decision, these two cases should be distinguished and given different consideration.

For definite policy-making, since the results are definitely at hand, the policy decision is simply choosing the optimum proposal based on available information. In doing this, the decision-maker should go all out with determination for the best result. Not enough determination and effort will mean a lost opportunity

and failure to obtain the optimum result even if the best plan is chose. This is a frequent cause of error in definite policy-making.

For indefinite policy-making, there are three considerations:

(1) "Play it by ear"; the pace should not be too fast. Avoid overconfidence and reckless action.

(2) Several schemes should proceed simultaneously in experimenting at the test stage. Each scheme should be different in principle. This not only makes the chance of success several times greater, but it also allows the accumulation of experience and even if the plan fails, the new policy will be on a good foundation.

(3) Concentrate efforts on signal feedback. Pay attention to information collection and consolidate the information in a timely way in order to make an opportune change of plan. In indefinite policy-making errors are unavoidable. The important thing is to discover errors and immediately consolidate the experience and change the course. If one held fast to the same approach even after errors were made, that would compound the errors and lead to disastrous loss. Never ignore the study of error, because a latecomer's success if often built on a pioneer's mistakes.

In addition, there are two more types of policy decisions in the indefinite category: risky policy-making and competitive policy-making. Each has its own rules of consideration.

For the risky type of policy decision, the following four considerations should be stressed:

(1) Choose the most promising plan of action.

(2) Prepare the necessary contingency plans so that any possible unanticipated event can be handled with ease.

(3) Have some leeway, such as backup troops in a war situation or a reserve fund in investment construction.

(4) Carry out test stage experiments whenever possible so as to change the high-risk policy decision into a more definite policy decision.

For competitive policy-making, the following four points should be kept in mind:

(1) Know your competitor well, check his strength and attack his weakness. The competitor's strength is an objective reality and cannot be denied or eliminated, but it can be suppressed so that it cannot fully develop. Pursue the competitor's weakness and use it skillfully. Causing the competitor to make the wrong decision is itself a good move.

(2) Know yourself well and develop your strength and hide your weakness. Attacking the enemy's weak point with your strong point is the basic criterion

of succeeding in competitive policy-making. If you find that your weakness cannot be protected, then it is better to cease the competition and consider other alternatives. Never force it.

(3) Take the enemy by surprise and thereby eliminate the opponent's strength and your own weakness from the contest. Surprises cannot be used repeatedly, the "empty castle trick" [a bluff] is wonderful but Zhu Geliang [6175 5514 0081] would never have used it twice.

(4) Make the strategy dynamic. The key to winning a battle often lies in a timely switch of strategy. Whoever stays ahead of the game will have the initiative.

It should be pointed out that the rules of competitive policy-making stated above apply to international competition. They should not be used in domestic competition between enterprises under socialist conditions. Here mutual assistance and cooperation should be stressed. This point must not be neglected.

3. The essence of policy-making is a systematic viewpoint with the overall picture in mind.

In large production, everything belongs to some level of the system. Within a given system, there exist complex mutual interactions between the part and the whole. Something desirable to the part may not be beneficial to the whole and may even be hazardous to the overall situation. Conversely, something unfavorable for the whole will eventually affect the interests of the parts. This calls for the leader to have a systematic view and to make policy decisions from a strategic angle. Specifically:

(1) Policy decisions must be made with consideration given to the entire system, the relevant system and the previous policy. They should all be compatible and coordinated.

(2) There should be a thorough understanding of which systems will be affected by the policy results and what countermeasures and changes these systems will provide in response.

(3) The policy should be developed systematically. Not only is the policy-making itself a project of system engineering, but the execution of the policy must also be carried out step by step. Subsystems of the next stage must serve the big system of the previous stage. This is the only way to guarantee final realization of the policy goal. If a policy is not carried out systematically, it is at best a "slogan," and there is no specific guideline to follow in the execution of the policy; sometimes there may even be totally irrelevant activities taking place, and this is the biggest mistake of a policy. In his book "The Effective Executive," Drucker cited an example where a company decided to make certain changes while at the same time promoting several conservatives to the posts of director and deputy directors; consequently, the reform failed. When the personnel subsystem contradicts the reform of the overall system, the principle of systematic development is violated. Similar incidents are not unusual here. For instance, the reform

policy of our industrial management system is specialization of production. It is no doubt a correct policy, but the policy has not yet been developed systematically. Take the tax system; if a product is taxed every time it passes through a plant, the cost is greatly increased in specialized production. This will invariably impede the administration of the reform policy of specialization.

In making systematic policy, the policy-maker must always remember to look at the overall picture before attending to the details. When a department is planning development schemes, for example, the strategy, goal and fundamental principle should be established first, and one should never dive into specifics. Stacking up a number of projects is definitely not equal to planning. Only when the various projects are organically put together according to strategy, goal and principle is it real planning. The objective of devising a plan is not to strive for one or two "winners," but to improve the entire development ability. Of course, after the overall picture is clearly defined, the details cannot be neglected either. Failure at the final stage due to an error in some detail is by no means unusual. But detailed arrangements are the business of subsystems at various levels; the main job of a policy-maker is to deal with the overall picture.

It is rare to have a policy-maker who is expert on both major and minor matters. Understanding the big picture and being hazy about detail is fine, but a leader who is hazy about the overall picture and sharp about details will be in trouble. A policy-maker who is ignorant about both the overall picture and the details is a disaster. It should be explained that the reason it is undesirable to have a policy-maker who is sophomoric on the overall picture and sharp about details is because he only appears to be bright, but he fools people and he fools himself. Such a policy-maker not only jeopardizes the policy system but also learns no lessons from failure. As for a leader that is ignorant about both major and minor matters, the problem is that he serves no leading function.

Finally from a system point of view, a leader should have a complete plan in making policy decisions. He should never discard the whole proposal and only adopt part of it. This will definitely disrupt the system, and no matter how sensible the part is, it cannot function. Of course, this does not rule out the possibility of extracting the sensible portions from various proposals, but they must be made an organic part of a new complete proposal. In policy-making, it is very hazardous to compromise the pros and cons with a principle. There are only two kinds of compromises: one compromise is like King Solomon's verdict on the two women fighting for the infant--split the infant in half and let each woman have half. The other kind of compromise is the so-called "half a loaf is better than starving with no loaf at all." The first kind of compromise is obviously absurd, but King Solomon's verdict is not the only one there is. For example, when there are insufficient research funds, cutting the funding for each topic by half is equivalent to splitting a lot of scientific research into half infants. The second kind of compromise, although workable, is a simplification that will not lead to the optimum benefit.

4. Democratic decision must be taken seriously.

A key step before making a policy decision is ample free discussion. For a major decision, the lower level staff who will be responsible for the administration of the policy should also be invited to participate in the discussion (participate in the policy-making). Democratic discussion has the following four meanings:

(1) Different opinions expressed during the discussion result in more proposals to chose from.

(2) Discussion always further optimizes the policy proposal. In the discussion, the advantages and disadvantages of various proposals are adequately exposed and different ideas can shed light on each other and broaden the viewpoints. The optimum proposal can finally be obtained by acquiring the strength and overcoming the weakness.

(3) The process of discussion is actually also a process of acquiring a unified understanding of the policy. Once the policy decision is made, it can then be carried out with one heart and one mind. This not only reduces impedance in carrying out the policy and keeps the policy in tact, but also helps everyone to develop initiative, to create and to progress.

(4) The reliability of the policy can also be improved through discussion. In case the policy is proven to be wrong in practice, the original dissident opinion will often be a ready remedy and it will not be necessary to come up with new ideas on the spot or be in a bind.

Hence, a wise leader will not make any policy decision without hearing the opposing view. For example, former General Motors President Sloan once said during a discussion of policy matter in an executive meeting: "Gentlemen, it seems to me that we are all in agreement in our view." The participants of the meeting all nodded their agreement, but he continued: "Now, I pronounce this meeting adjourned and we will meet again to make the decision when we have heard some different opinions. By then we may gain some real understanding of this policy." One cannot say that the fact that General Motors became the leader of the world automobile industry is unrelated to this attitude of taking democratic discussion seriously.

When different opinions are aired in the policy-making process, it is particularly significant to have academic discussion, because academic discussions are evaluated on the basis of real insight and understanding, they are relatively removed from the various interests, and different opinions are more likely to be developed fully. Moreover, scientific discussion rules out circumstantial factors such as interpersonal relations and gets to the scientific core of the problem. Although decision-making should be versatile, the versatile factors can be handled correctly only on the basis of this scientific core.

III. The Decision-making Aptitude of a Leader

In a sense, the modern decision-making aptitude of a leader is the basis for scientific policy-making. Its basic requirements are:

1. Creativity

Policy-making is a creative activity and it always had the premise of altering the status quo. One can therefore say that without creativity there is no policy-making.

Any policy has its time period. Traditional customs and old rules and styles are the results of yesterday's policy. They may be selectively adopted, but they will never suit the present situation completely and solve today's problems. No matter how good they are, yesterday's policy cannot take the place of new policy. The famous economic management scholar, Nobel Prize laureate Simon, once said: "Management is a series of policy decisions." It is indeed an opinion with insight.

Even a talented leader with brilliant achievements should never be complacent. He still needs to be constantly creative and pay attention to strategic and overall innovation. Each level has its own strategy, and there is room for the talent of leaders at all levels.

To be creative one must break away from stale thinking, timid behavior and idleness. Since old ways had their success, their limitation is often masked, people used to old customs tend to hang on to them and follow them unconsciously. Therefore, following the old custom is the first culprit in dulling the creativity of a leader.

2. Scientific attainment

So-called scientific attainment is not a demand for the leader to master all scientific knowledge, for that would be impossible. Instead, it means that a leader should have basic training in science and possess a broad scientific knowledge and method of thinking.

Scientific training can be carried out through school education, but most important is self-education. One should study politics, economics, science and technology, management, philosophy, geology and history. In a word, one must be able to handle a multitude of social values and thereby conduct effective strategic thinking and make the correct value judgment on topics that cannot be compared directly.

In order to make science policy decisions, a leader should have the following scientific attainment.

(1) He should be skillful in the use of Marxist philosophy and the cognition and methodology of dialectical materialism.

(2) He should be familiar with a basic knowledge of economics.

(3) He should understand the basic ideas of system theory, information theory and control theory.

(4) He should study modern management and have a general understanding of modern administration.

(5) He should keep a close eye on the development and direction of domestic and foreign politics, economics, science, technology, education and culture.

(6) He should have a cursory knowledge of history, especially contemporary world history and the history of China.

3. A democratic work style

Democracy naturally implies that the leader should listen to different opinions with an open mind in making policy decisions; he should be particularly good at absorbing useful points from dissident opinions. But letting people speak out is not the entirety of democracy. Following suggestions is something even a "wise ruler" like Tang Taizong could manage. Democracy has its own deep scientific content and vigorous scientific structure.

Before a policy decision is made, all schools of thought should be allowed to aid their views without fear of reprimand, and different dissident opinions should in fact be encouraged. After the decision is made, it must be carried out in its entirety by everyone with one mind and one heart, and no discrepancy in action should be allowed. Both of the above are equally important and it is not true democracy without either one. Only scientists and specialists in think tanks have the privilege of always airing different opinions, because they do not participate in the execution of the policy and their job is feedback.

In the policy-making process, the democratic style of a leader can be demonstrated in the following ways:

(1) Sincerely listen to different opinions, not just pretending to be receptive.

(2) Be good at extracting different ideas. By repeated comparison and consideration of the overall situation, find the necessary material that meets the objective requirement out of the tangle of various ideas.

(3) Have the courage to adopt correct ideas. A leader may decide on a policy based on the opinion of the majority or he may go against the masses and follow the idea of a few people, it all depends on which is correct. The famous "National Income Doubling Project" of Japan was based on the opinion of a small minority represented by economist Shimomura Osamu and it finally succeeded.

A democratic work style is also illustrated by the leader's voluntary acceptance of responsibility when the policy is proven to be wrong.

4. Courage of determination

Time is a great resource in modern management and it is an important factor in modern policy-making. The optimum policy is always optimum with respect to a certain time and space and the conditions in this space and time. Therefore a leader must have timely courage to make a determination. Delaying a policy decision will bring about new risks in the process of delay, and the original optimum proposal will lost its base.

A leader's determination and resolve can also mobilize the subordinates and masses to carry out his policy confidently. Otherwise, even though the policy decisions are made, they are still in vain. Lenin instructed us to be firm to make others firm. Drucker wrote in his book, "The Effective Executive": "A manager must often speak with positive foresight in certain circumstances; lacking this ability may lead to grave consequences."

Among the four aptitudes for policy-making discussed above, creativity is the prerequisite for all decision-making; without creativity, the other three aptitudes are meaningless.

Comrade Chen Yun once said: "In our work we should spend more than 90 percent of the time studying the situation and use less than 10 percent of the time making decisions." This shows that science policy-making is not easy, it often takes a tremendous amount of effort and intelligence of leaders at various levels.

In the long practice of revolution and construction, our leaders at various levels have accumulated a wealth of practical experience. If they can further manage to use the procedure and method of modern scientific decision-making and improve their aptitude for science policy-making, their ability will be greatly enhanced and abundant, fruitful results will be achieved through their policy.

(Edited by He Zhongxiu [0149 6988 4423])

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BUILDING EFFECTIVE LEADERSHIP TO GUIDE AN EFFECTIVE SCIENCE POLICY

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[Article by Xu Weixiong [1776 0251 7260] and Li Weikai [2621 4850 0418] of the People's Liberation Army: "Applying Systematic Thought, Strengthening Systematic Leadership"]

[Text] Just as the interaction and overlapping of various disciplines produced scienology, the interaction and overlapping of administration, politics and education formed the complete leadership of the party over science and technology. The system is an organic whole and the optimization of the whole system should be sought. In the party's leadership over science and technology, we should seek the overall effectiveness of administration, politics, and education. When only one aspect is stressed, it violates the principle of the system.

Today the following shortcomings exist in the leadership of science and technology: (1) The five large research systems characterized by administrative leadership are independent systems and do not form a complete structure of China's scientific system. (2) The leadership of sciences and technology is often singular; it may be administrative leadership, or political leadership, or academic leadership, but not an organic combination of all three. (3) The composition of the leadership often consists of only one factor; it may stress administrative leaders or it may stress scientists, but it does not stress a rational structure of intelligence or the optimization of the team. (4) The theoretical foundation for scientific and technological leadership is often limited to one discipline or specialty, and not the interactive combination of social sciences, natural sciences, engineering technology and management science. Because of these drawbacks, science and technology is inevitably partial and administratively it is often "rigid" or "all of one suit." For example, the electricity problem was unsolved after the Wuhan steel rolling mill was built; scientists are still advocating the construction of a fish channel after the Gezhouba dam has blocked the flow; investment on the Baoshan steel mill is already underway, yet the source of raw material has not been resolved. These are all examples demonstrating the problem.

Dialectic materialism affirms that the material world is a unified entity made up of numerous interrelated, interdependent, mutually constraining and mutually

interacting matters and processes. Systematic thought is the unifying of this material world and a concrete realization of dialectic materialism. The development of modern science and technology has further quanitified the method of systematic thought.

If we view the party's leadership of science and technology as a complex engineering system, then any policy decision in leading this engineering project not only requires the art of leadership but also the science of leadership. By using systematic thought combined with natural science, social science, engineering technology, scientific management and, especially systems engineering, then practical proposals based on quantitative analysis and scientific policies can be generated. In the mid-19th century, capitalist countries used engineering technology and developed their production; in the 1960's, industrially developed nations extensively applied systems engineering and achieved success such as the Apollo project; in the 1980's, we are consciously using systematic thought in leading our S&T effort, and this will have a profound effect on the four modernizations of China.

How do we use systematic thought in strengthening our S&T leadership?

I. Insist on Systematic Leadership

In systematic leadership, one must first organize the objects into a system (an organic entity with goals, functions and levels). Systematic leadership is not a leadership of point or line but a leadership in three dimensions. For example, a research unit as an operating system (it is also a subsystem belonging to a higher level) has a number of subsystems such as party affairs, scientific research, service and maintenance, education, and research management. Among these subsystems, there are mutual interaction (interpenetration and combination) and mutual reliance. These relationships should be realized in each basic link of the system. A leadership system should therefore possess the following features: (1) It should be complete. Adding up the merits of the individual parts does not equal the merits of the whole. The entirety can only be optimized when the constituent parts are logically unified and coordinated into the entire system. (2) It should be integrated. A complex system touches upon many aspects; it involves technological factors, economic factors and social factors, and it requires scientific knowledge of mathematics, management, economics, engineering, control theory, scienology and psychology. It would be exceedingly difficult for one person to know them all. In the actual practice of leadership, it is therefore important to organize various specialists and have them study with the leadership. (3) It should be practical. One should strive for the best results in carrying out a specific function of the system; however, specific functions of the system consist of many goals and targets, and sometimes one must seek a rational compromise or middle ground among conflicting functional requirements in order to coordinate the many factors. This is the practicality of leadership. This kind of systematic proposal based on pragmatism should be stressed in leadership.

How should systematic leadership be carried out?

First, an appropriate leadership structure should be established. The structure here refers to age, specialty, intelligence and aptitude. People of different ages have different intelligence characteristics and capability; a leadership group composed of people of different ages has a more rational age structure. A leadership group made up of different talents is a collection of administrative management talent, political leadership talent, "hard specialists" knowledgeable in special disciplines and "soft specialists" with management training so that the leadership can be "all knowing." The leadership aptitude consists of abilities to think, to express, to organize, and to direct. All these abilities can be realized collectively by having able thinkers, organizers and executors. A leader should be clearheaded, open-minded and knowledgable, and have broad interests and high integrity. Having such a leader will give the leadership group strong fighting power to coordinate and unify. Based on the discussion above, a leadership structure should be multidimensional and dynamic. Once formed it should not remain the same forever; it can be progressively optimized through constant practice.

Second, a powerful "think tank" should be set up. These are the "idea men" and "advisers" of the leadership and as a whole it is the research institute for policymaking and a "reprocessing plant" for thought. A think tank may recruit talent without being restricted to a specific type; it should broadly absorb creative middle-aged and young people so that it is vigorously active and sharp in perception. With proposals processed by such a pool of talent, the probability for error in decisionmaking by the leadership will be greatly reduced.

Third, coordination and equilibrium within the system should be strengthened. System equilibrium here refers to the matching of personnel flow, material flow and information flow between system and subsystems and between subsystem and basic links. For a given set of objective conditions, then this matching relationship reaches equilibrium, the entire system will function with optimum efficiency. Since the system is constantly in a dynamic state, the various systems may be coordinated frequently, so that they proceed from nonequilibrium to equilibrium, and from a new nonequilibrium and to a new equilibrium, and so forth. Efforts should be made to shorten the period of nonequilibrium and to consciously create favorable conditions for equilibrium in order to promote the development of scientific capability.

Science and technology have their intrinsic rules of development; this process may be enhanced or hampered depending on the action of the leadership. Science and technology is a whole entity and systematic leadership is a sensible conclusion.

II. Establish an Effective Feedback System

Feedback is a common phenomenon in nature, and the principle of feedback has been widely used. When feedback is not working it produces chaos in management. In view of the self-directing and self-feedback reality in China, it is particularly urgent and significant to establish a feedback system.

Based on the situation in China, we propose a feedback system consisting of the following components:

1. Science and technology associations and academic committees.

These academic organizations are meeting and activity centers for scientists. They constitute an enormous force in promoting scientific and technological development. Through the consulting and advisory role, opening up academic exchange and collaborative research will have a good effect on the party's science and technology policy.

2. Advisory organization.

Today some old cadres with leadership experience and old scientists and specialists with achievements have served as advisors to various levels of leadership. They have also formed an advisory group, office or corps, and have made suggestions on problems in the party's science and technology policy and practice. This is an important link in the feedback system.

3. Think tank.

In the present Chinese system, most S&T administrative leadership offices do not have an administrative or investigative research office devoted to policy research and investigation or doubling as a secretariat. Through situation assessment, research and reprocessing after the output of the signal, new or modified proposals on policy decisions may be proposed to help the policymaker regarding new decisions. This is also essentially a feedback process.

4. Information system.

People rely on information on their understanding of the society and the natural environment. International competition in science and technology primarily relies on a highly efficient information system. It may be said that information is a prerequisite for an effective feedback system.

5. Feedback management organization.

Based on the actual situation in China, management organizations at various levels could have two functions--that is, they may be management organizations and feedback management organizations at the same time. Personnel may be assigned exclusively to accumulate and collect various types of data. Reprocessing, analysis, and investigation are then conducted on the large quantities of feedback signal, and suggestons and specific proposals can be proposed from a scientific management point of view. This process will also play the role of feedback.

Naturally a feedback system also contains other components, but if we can consciously make the above items work, we will be helping to establish an effective system and make the party's leadership in science and technology even more scientific.

(Edited by Lou Lingru [1236 5024 0320])

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SPECIALISTS, NOT BUREAUCRATS, SHOULD LEAD DECISION-MAKING PROCESS

Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese No 5, 20 Oct 81, pp 7-10

[Article by Wu Heqing [0702 0735 3237], Yao Dexi [1202 1795 0823], and Lou Daoming [1236 6670 2494] of the Hunan Provincial Science Committee: "Several Problems in S&T Policy"]

[Text] Establishing and carrying out the correct policies on science and technology is of strategic importance to the development of scientific and technological enterprise. For a long time there was essentially no practical, stable policy on technology because of major technical problems in the development of the national economy. The industrial fuel structure switched from the burning of coal to oil and then back to coal. The selection of railroad traction power was in controversy. All these issues resulted in great loss due to the ambiquity and switching of technological policy.

Experience has shown that the policy on science and technology as a guiding strategy and principle for the entire science and technology enterprise is a powerful weapon for the promotion of the national economy, and people use it in handling and adjusting the various internal and external relations in the realm of science and technology and in the promotion of the scientific and technological enterprise. We should make full use of this weapon and do a good job in science and technology management.

I. Principal Contents of a Science and Technology Policy

The scope of a science and technology policy is very broad and covers both macro and micro aspects--from major policy decisions on national strategic development to a specific technology policy regarding some local issue. We believe the major contents should include the following:

1. Science policy, or policy governing the development of natural science (theoretical science).

This policy deals mainly with development strategy and the overall goal of science. Examples are the infrastructure of a nation's science and technology, the arrangement of scientific disciplines, the ratio of military science and civilian science, the selection of leading science and the target for excellence.

2. Technology policy, or technological economic policy.

In establishing this policy, the technology of a specific field must be investigated to see if it is progressive, suitable and economically feasible. Regarding small steel mills and small chemical fertilizer plants, for example, the questions of whether they should be improved technologically or phased out and how to improve them or how to phase them out must all be spelled out clearly in policy form after investigation, study and conclusions are properly made.

3. Science and technology management policy.

This policy involves primarily investigation of the nation's scientific and technological development as a whole and the study of what policies need to be established to guarantee a coordinated development within the structure of science and technology and a consistent development with the external structure--the entire economy and society. A coordinated development of science, economy and society is the current policy of China's scientific and technological development. Regarding how to combine the three aspects organically in actual practice, there should be a set of methods, that is, there should be some corresponding policy regulation to insure the realization of this goal.

The reason that science and technology policy should be divided in this fashion is that science, technology and the management of science and technology are three different concepts, each has its own system and structure and is independent. Generally speaking, the essence of science is knowledge, a theoretical knowledge system consisting of various knowledge units, and is characterized by the exploration and understanding of the rules and development of and change in the objective world. The original meaning of technology is "skill." Skillfulness leads to ability and technology. Technology is the application of science and is a tool of labor. Science and technology are mutually related. From the viewpoint of science structure, science consists primarily of basic science, technological science and applied science. Each science category contains its scientific theory and its physical and chemical technology. Therefore, when we look at science and technology, we should look at their distinctions as well as their interdependence. Because they are different, they can be categorized, and because they are interrelated, the division is only approximate, relative and not absolute. A prominent trend in modern science is the combination and merging of different disciplines, and our thinking should adapt to this need. As to management, it was regarded as a "social education" for a long time and was not considered to be a branch of science. But experience has proven that an old hand in class struggle and mass movement may not necessarily be able to do a good job in science and technology management. Even someone experienced in production organization and management may not do well in science and technology management. Science and technology have their own rules and characteristics. The central task of science and technology management is to follow these rules and characteristics and to collect and process information regarding such fields as social psychology, behavioral science, technological economics and system science, and to carry out policy decisions, planning, personnel and fund deployment, organizational coordination, monitoring, and adjustment. To this end, a complete system of

procedures must be established to achieve the optimum results in scientific and technological development.

As can be seen, science, technology, and management each has its own structure and system, and the distinction and relationship between them are subjective. These problems must be taken into account in formulating policies on science and technology. It should also be realized that in reality the three types of science and technology policy, although each has its own emphasis, are often mutually interconnected and related and cannot be separated mechanically. For this reason, the important thing is to look at the policy itself and see if it reflects the requirements of the objective rules and whether it can advance the development of the scientific and technological enterprise.

During the period of economic readjustment, the Party Central Committee and the State Council have reiterated and emphasized the policy of science and technology serving the economic construction and pointed out the direction for our study of science and technology policy. How to adjust and modify old policies, what new policies need to be established, and particularly how to set up local policies on science and technology consistent with the actual local situation are problems of extreme importance and urgency. Scientific committees at various levels and various management branches of science and technology should actively promote and organize specialists and scholars to participate in the study of science policies and propose different plans for the choice of the policymaking offices. Policies calling for immediate study and formulation are: coordinated development of science and technology and economy and society; proportion of various investments for scientific research; policy on scientific competition and collaboration; talent development policy (or intelligence investment policy); policy encouraging scientists and technical personnel to aid remote and minority areas; and policy on technology transfer.

II. Basis for Drawing Up Policy on Science and Technology

The formulation of any policy must have a basis, and science and technology policies are no exception. Collectively, there is a theoretical basis and an actual basis.

The theoretical basis for establishing scientific and technological policy is scienology. Scienology is a comprehensive science centered on the study of the development of natural sciences. Under the guidance of Marxism, the basic tasks of scienology are exploring the intrinsic characteristics of science as a whole, investigating the rules of scientific development, and seeking the optimum method of scientific management in order to speed up the progress of science and technology modernization and to promote the scientification and modernization of the entire society. Therefore, one must possess and apply the theory of scienology in guiding the study and formulation of scientific and technological policies.

The so-called actual basis refers primarily to the driving force of scientific and technological development. This driving force can be divided into an internal driving force and an external driving force. Within science and technology there are rules of antagonistic movement, and this antagonism is the internal driving force. The other kind of driving force comes not from

within but from the entire society, that is, the external driving force is the multitude of factors affecting the development of science and technology. The formulation of science policy should be objectively based on both the internal and the external driving force. In addition, once the policy is determined, it also serves to adjust the relationship within science and technology and with the external environment, so that both the internal driving force and the external driving force can play their proper role and lead to satisfactory results. The dialectic relationship between science policy and the development of science and technology is well worth our attention.

Concerning the actual basis in formulating scientific policy, we should analyze the following three aspects:

1. Scientific ability.

Historical examples in science and technology cannot be used as a basis for formulating scientific and technological policy; only real scientific ability can be a reliable basis for establishing policy. The essentials of scientific ability are: scientific and technological staff and management personnel, research funding and equipment, literature and information, optimization of the scientific force and the level of a nationwide science education. Among the various factors, the human factor is the deciding factor of scientific ability. The percentage of scientific and technological personnel in the population is an important indicator in evaluating the scientific ability. In addition to quantity, quality should also be looked at. Quality may be judged from two aspects: one is the proportion of senior scientists and technical personnel and the other is the average age and the age composition of S&T personnel.

When we speak of the modernization of science and technology, the first issue is the modernization of scientific ability. The ranks of science and technology are the most volatile factor in scientific ability, and the quantity and quality of this group is an important basis for policy formulation.

2. Social momentum.

Science and technology are the means to achieving certain economic and social goals. If the economy and the society do not stress and make good use of this means, there will be no social impetus for the development of science and technology. Many complex factors enter into the social impetus; among them, the two most important aspects are: first, the scientific cultural level of the people and their demand on science and technology; and second, the actual ability of the societal economy to support science and technology.

Experience has shown that for a given set of circumstances, the speed of scientific and technological development depends on the degree of understanding, appreciation and awareness of science and technology by the people. In particular, it depends on the understanding, appreciation and specific action of the policymakers of the scientific organization management and the economic organization management regarding such important issues as "science and technology as a production force" and "science and technology leading the production construction."

We are now in a period of national economic readjustment, and the actual economic support is limited. It is not hard to understand that great sums of money for science and technology are an impossibility. The problem now is that the proportion of investment in building up the science and technology enterprise is not as clear-cut as the proportion of agriculture, light industry and heavy industry. Granted that there is no established international model on the proportion of research investment and that situations vary from province to province in China, but there still should be a proper and stable proportion. According to figures given at the inquiry of the third meeting of the Fifth National People's Congress, the percentage of China's scientific research expenditure relative to the annual gross value of production is: 0.88 percent in 1979 (final account), 0.86 percent in 1980 (budgeted) and 0.84 percent in 1981 (projected). This indicates that the proportion of scientific research funding in China is still small and unstable. Problems like this can only be solved by policy before the science and technology enterprise can enjoy steady progress.

In one aspect, economic and social development in the past relied very little on science and technology, nor did they provide much support for science. But we should also see the other aspect, that is, as clearly pointed out by the Party Central Committee, development in education, science, culture and health efforts should be continued as much as possible during the readjustment. As the policy of developing potential, protecting competition and promoting collaboration is being carried out, as the management of industrial and mining enterprises are being improved and strengthened, and as the rural production responsibility system is being improved and perfected, the degree of reliance on science and technology by industrial and agricultural production has reached an unprecedented level and the social impetus for scientific and technological development is growing constantly. In ideology and in action, we must keep up with the developing situation and make it our primary task to solve the key scientific and technological problems in economic development, improve the management standard and satisfy the needs of economic and social development with science and technology to the maximum level and make new contributions.

3. Ecological and environmental impact.

The policy of science and technology must be conducive to the ecological balance. In the early 1970's, an antiscience movement appeared in America and Western Europe, one of the reasons being that science brought disasters to mankind and produced pollution. This has cautioned us that attention must be given to ecological balances and environmental protection while we develop science and technology. For example, Hunan Province has superior geological conditions and natural resources, but for various reasons its ecological equilibrium has suffered serious damage, which has led to reduced forest coverage, deteriorating weather conditions, water and soil losses, silted up rivers and lakes, and a sharp drop in aquatic products. Because of a management style that pillages, the ecological system is severely overloaded and the consequences are evident. When we study and formulate policies on science and technology, we must stress strongly that under no circumstances will we trade a rapid development in industrial and agricultural production for the deterioration of resources and environment. Ignoring the protection of the

ecological system is committing a crime with regard to the generations to come. Therefore, in developing science and technology, we must consider the best economic effect as well as the best social effect. Scientific progress and human benefit should be the beginning and the end of the study and formulation of scientific and technological policies.

III. The Significance and Method of Scientific and Technological Policy Study

To formulate a science policy, one must have the correct theory, method and technical means. For a long time we have lacked a serious study of this issue. A strengthened policy study will undoubtedly help us gradually overcome thoughtlessness and one-sidedness in policymaking and establish a timely science and technology policy that is both rational and compatible with the situation in China.

In the extreme case, if a policy study were not conducted, it would cause great difficulty in the formulation and execution of S&T policy or even make it impossible. Policy study is therefore extremely important. Because of its importance, more and more people here and abroad are concerned with the study of S&T policy. By the early 1970's, there were 200 institutes in the world devoted to the study of S&T policy. There is one or more national level research institutes in every developed nation, and many developing nations have also established such institutes. In addition, international research institutes such as the international S&T Policy Commission and UNESCO have also been established.

In the early period in China, the Academia Sinica was not only the highest scientific research institute in the nation but it also assumed some management duties of the national science and technology effort. Major S&T policies were often proposed by the Academia Sinica and approved and acted upon by the then Political Council. By 1956 the National Science Planning Commission was established in the State Council, and in 1958 the National Technological Commission was established. In 1961, the Science Planning Commission and the Technological Commission were combined to form the State Scientific and Technological Commission. Since then, the study and formulation of national S&T policies have been conducted by the State Scientific and Technological Commission. Today, 18 provinces, municipalities and autonomous regions have established S&T policy offices.

When the State Scientific and Technological Commission formulates a policy, it first hears the opinions of science and technology workers in various departments. The S&T policy in question is first discussed in specialist groups and special meetings. The opinions are then consolidated and a policy paper is finally written and submitted to the State Council, which then evaluates, approves and promulgates the policy. This procedure serves as a good reference for us.

S&T policy study is an interdisciplinary investigation; it not only involves many disciplines in philosophical and social sciences but also some disciplines in natural science, technological science and engineering science. In order to

do a good job in S&T policy study, we must consistently rely on experts and scholars.

There are five methods in the investigation of S&T policy: (1) status investigation, (2) historical comparison, (3) future prediction, (4) systematic consolidation and (5) policy optimization. These five aspects are not only the working methods of S&T policy study but also the working procedure (or steps) of S&T policy formulation.

There should also be relative independence in the study of S&T policy. This independence is demonstrated in two areas:

First, a certain dependent relationship must be overcome. Today the management level of science and technology in China is not high enough, so that scientific and technological research is often led in a bureaucratic fashion and major policy decisions often rest with individuals. This dependent relationship must be overcome in carrying out policy study; otherwise, it will be impossible to formulate correct S&T policies.

Second, comment and discussion should be allowed on whether the current S&T policy is appropriate or whether the present policy should be adjusted and modified as time and the situation change. This is an important ingredient of policy and should never be neglected.

In this article we have given some of our parochial viewpoints and we do not expect them all to be correct; we welcome your corrections and criticism.

(Edited by Xiao Cheng [2556 3397])

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NEED FOR CONTINUED DEVELOPMENT OF SCIENTIFIC TALENT FOCUSED ON

Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese No 1, 20 Jan 82 p 61

[Article by Yang Long [2799 7893] edited and released by Song Hezhou [1345 3109 3166]: "Developing the Strong Points and Avoiding the Shortcomings in the Employment of Scientific and Technical Cadres"]

[Text] In realizing the four modernizations, a very important link is the modernization of management. To improve our existing level of management, a fundamental strategic measure is to promote the large number of cadres who insist on the four basic principles, who are young and strong and who possess special knowledge, to the leadership posts at each level and to make the leadership groups younger, more intellectual, and specialized.

The selection and promotion of middle-aged and young scientific and technical personnel to the leadership groups at each level cannot be neglected and delayed. The urgency of this point has been more and more profoundly felt by all. Everyone has recognized that this must be grasped firmly and early.

There are a group of specialized technical cadres now, and some of them are in the technical vanguard. Some are comrades who have made great contributions in scientific research and who have already climbed the ladder of promotion to leadership posts. For example, a scientific and technical worker of a certain research unit had realized outstanding achievements in scientific research and was praised by the higher authorities. He attended the National Science Conference, and later won further trust and appointments and was promoted to deputy director of a certain research institute. Undoubtedly, there are many advantages in having such scientific and technical cadres lead and manage scientific and research work.

It is necessary to fill the leadership groups at each level with special technical personnel, and this must be done without reservation. But what type of special technical cadres should join the leadership groups so that their strong

points can be fully developed and so that they will benefit the building of the four modernizations? This is a problem that requires conscientious research and rigorous treatment. If it is not handled well, the opposite will result.

Take the above deputy director as an example, after his promotion, he had to attend this meeting today and that meeting tomorrow, make a report here today and talk about his experience there tomorrow. He had to hold more than 10 concurrent posts, and he was invited here and invited there, and his life was chaotic. In his own words: "I do not know what I am doing all day now, and I feel at a loss to handle all this." The masses complained: "He has now become a conference cadre, frequently attending conferences elsewhere."

This deputy director has already realized academic achievement. If he is allowed to continue to study and do more research, he may produce even newer inventions or creations. If some assistants are assigned to him to cut down his business activities, he will have more time to engage in research, and it is also possible to train another new force. But now, the result of his appointment has made it "difficult for him to handle the situation." This not only wasted his research work but also created loss and waste in actual work which cannot be calculated.

Now, in economic work, everyone often talks about developing strong points, avoiding shortcomings and developing superiority. Such a problem also exists in the use of talented people. We must develop their strong points and avoid their shortcomings, utilize their skills, appropriately arrange jobs according to their special own skills, interests and likes before we can fully mobilize their enthusiasm and creativity. This is the correct way of using cadres and caring about talented people.

We know that every one's knowledge, work experience and work performance are different. Some have a good grasp of basic knowledge and possess a wide range of knowledge, they are good at thinking through problems, and it is suitable to let them do research work. Some are very active, they are good at organization and liaison and they have a strong spirit in doing things. Therefore, we must select different cadres according to different work posts to let each of them be responsible and to let each of them develop his own capabilities. Scientific and technical personnel engaged in scientific research and scientific and technical personnel entering the leadership group are completely different according to work demand, the nature of the job and the content of the job. Each profession has its own special talent, different content and criteria, and they cannot be equated. A person talented in mathematics may not possess talent in organization and leadership. A world famous high energy physicist may not be able to organize and lead a high energy physics research institute with a hundred or a thousand members well.

Allowing scientific and technical personnel to join the leadership group is a necessity in building the four modernizations and changing the present structure of the team of cadres. This must conscientiously be done well. We must strengthen investigation and research and start out from actual work, analyze the overall situation and weigh the facts to see how we can employ scientific

and technical cadres so that they can better develop their strong points and make even greater contributions to building the four modernizations. People who are very talented in scientific research should be allowed to continue to develop their superiority in scientific research work. Do not force them into leadership posts and have them do work that has nothing to do with their speciality. Those people who possess the qualifications and who can better develop their function and who will be more beneficial to pushing the overall work forward after being promoted to leadership posts should be promoted without fear. The principle is rational employment. We must not suppress talent nor should we waste talent.

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THREE-STEP THEORY ON THE STUDY OF SCIENTIFIC DEVELOPMENT VIEWED

Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese No 1, 20 Jan 82 p 31

[Article by Zhang Jingchen [1728 2529 2525] of the Jilin Provincial Social Sciences Academy and edited and released by Zhao Beiwang [6392 0554 2598] and He Zhongxiu [0149 6945 4423]: "'The Three-stage Theory' on 'the Study of Scientific Development'"]

[Text] The "study of scientific progress" is basic research in scienology and it is used internationally to differentiate it from "the study of scientific policy." Analysis of related surveys conducted by the United Nations Educational, Scientific and Cultural Organization shows that the subject of "the study of scientific development" includes the three basic concepts of "science," "scientists" and "scientific study." This article briefly describes the content and the extension of these three concepts and their theoretical meaning in the basic study of scienology. The ideological method used here follows the "three-stage theory on the development of physics" proposed by Japanese theoretical physicist Mr Takeya. The so-called "three-stage theory" says that "the development of physics manifests the following three stages: First, physics describes the stage-in-itself of phenomena--the theory of the phenomena stage. Second, physics explores which stage-for-itself structures are possessed by certain actual objects--the theory of the objects stage. Third, physics studies what principles of motion are followed by objects in the stage-in-itself and stage-for-itself under mutual action--the theory of the nature stage. These three stages are not predetermined to occur in order. Because nature has such a symmetric structure, this development has come about because people's understanding of it has gradually deepened step by step. This is the consistency of historical development and logical structure." In fact, the subjects investigated by the "study of scientific development" has a similar symmetric structure.

The term "science," as defined in modern terms by the "Oxford" and "Ci Hai" dictionaries, refers to the system of knowledge about nature, society and thought. It is the sum of the fundamentals and the applied parts of natural science, social science, psychological science, mathematics, philosophy. Such a broad understanding of the concept of science is not an effort to disregard the historical fact that scienology has emerged and developed along with the emergence of "macrocosmic science" in modern natural science, rather, the trend

toward universality of modern science does not objectively allow for the classical narrow concept of science. Of course, out of the need for division in scientific research, we can limit the subject of study to within the realm of natural science, but we should not lable this "scienology," we should rigorously name it "science of natural science." This can clarify the conceptual confusion in the study of scienology. If we study the structure and structural variation of science as a system of knowledge, we can obtain a description of the theory of phenomena in "the study of scientific development" because "scientific progress" is the record of achievements, not the actual body of "scientific development." Therefore, science is the subject described by the theory of phenomena in the "study of scientific development."

What we call a scientist is a worker who is engaged in creative scientific exploration. He is the sum of the natural scientist, social scientist, pyschologist, mathematician and philosopher who engaged in scientific discovery, technical inventions and engineering creations. In the modern sense, the scientist exists individually and he also exists as a group which has a definite composition, structure, function and which is equipped with modern means and equipment of exploration. If the structure and structural variation of the scientists is studied as an explorer of knowledge, then we can obtain a description of the theory of objects in the "study of scientific development" because the scientist is the initiator who produces scientific knowledge and who develops scientific knowledge. He is the "actual moving object in scientific development." Therefore, the scientist is the subject described by the theory of objects in the study of scientific development.

What we call scientific research refers to the creative labor of scientists in carrying out scientific exploration. It is the sum of basic research, applied research and developmental research in nature, society and thought carried out by scientists. In the modern sense of scientific research, we often use "research and development" to bring out the characteristics of modern scientific research because developmental research has already become an important link directly connected to material production. Its investment is the largest and its social effects are the most obvious. If we take scientific research as an activity to explore knowledge and study the principles of dynamics of such activity, i.e., the principle of interaction of the various elements within the dynamic body and the principle of interaction of the dynamic body with the various external elements, we can obtain a description of the theory of nature in "the study of scientific development." Therefore, scientific research is the subject described by the theory of nature in "the study of scientific development."

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APPRAISING SCIENTIFIC INVENTION ON BASIS OF MARXIST METHODOLOGY

Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese No 5, 20 Oct 81, pp 10-12

[Article by Duan Ruichun [3008 3843 2504] of the Chinese Science and Technology Information Bureau: "Probing Into the Standard for the Appraisal of Inventions"]

[Text] Invention is skillful creation by human intelligence. The quantity and quality of inventions are often indicators of the rise and fall of a nation's science and technology. Proper appraisal and encouragement of invention is an important S&T policy for any nation. In China, after the smashing of the "gang of four," the State Science and Technology Commission reissued the "Invention Encouragement Ordinance." Experience of the past few years has shown that this decree has played an active role in promoting invention and creativity, stimulating science and technology, and developing the productivity of the society. In the meantime, it has also raised an important issue in science management, namely, how to recognize the fundamental nature of an invention and how to establish an objective appraisal standard for inventions.

The second article of the "Invention Encouragement Ordinance" states that: "An invention is a major new achievement in science and technology. It must satisfy the following three conditions simultaneously: 1 it has not been done before, 2 it is advanced, and 3 it is experimentally proven to be applicable." These three conditions constitute the basic nature of invention, namely, novel, advanced and applicable. They may be considered the unification of the dialectic; they are mutually related and yet distinguishable from each other, and collectively they demonstrate the role of invention in S&T activity: from nothing to something, from the simple to the sophisticated, and from practice to theory and then back to practice. Therefore, in the study of the appraisal standard of invention, it all comes down to using the scientific view and methodology of Marxism in evaluating the novelty, sophistication and applicability of the scientific significance of an invention and the specific principles of judging and determining these three basic characteristics. In this article, we will provide only a preliminary exploration of these topics.

I. Definition of Invention

What is invention? Invention is a dynamic concept in the creative activity of technology, and we should give invention two dynamic definitions along with the progress of natural science. On this ground, we may specify our fundamental understanding of invention: 1) between science and technology, invention is in the realm of technology; 2) as compared to discovery and creation, the concept of invention is related and yet distinguishable from them.

It is generally believed that invention, discovery and creation all provide new knowledge and information to mankind; however, discovery often refers to the jump from not recognizing objectively existing objects, phenomena and principles. On the other hand, invention is a technological creation from nothing to something using the above recognition. But invention is not equal to creation. Creation is a concept that is deeper and more far-reaching intensively and extensively; it includes the formation process of a variety of material and spiritual achievements in the broad realm of human society. Invention is only a subarea of the broad concept of creation.

Obviously, from the nature of the subject, the theory and method in natural science and social science and the principles and calculations in mathematics do not fall in the invention category. Simple discoveries and literary and art creations are not inventions either. The kind of invention we wish to appraise refers to scientific and technological results that are technical in nature and are characterized by their novelty, sophistication and applicability.

II. Novelty of Invention

The novelty of a scientific or technological achievement can only be judged by comparing it with technology known and used before (we might call it current technology). Thus, the appraisal of novelty may be concluded by a counter-argument process: if a new scientific or technological result is technologically the same as some existing technology, then the new result does not have novelty. Otherwise, the new result would be novel. There are two questions here: what is current technology and how are two things judged as being technologically the same.

Regarding space, current technology may be regarded as the technology published in publications of the world, openly used and publicly known by society in various forms. Regarding time, there is no limit in dating backward. Regarding the medium, the criterion should be multimedia, such as information transmitted through oral reports, audio recording, video recording, television, movies and microfilm.

Regarding sameness, or judging whether two scientific and technological results are the same, one should first pay attention to two categories of sameness: 1) two techniques are identical, that is, there is no difference in the principle, mechanism or result of two inventions or technological results; 2) two techniques are partly the same and partly different; the part that is different, judging from the technological level of the time, is a simple

substitution of publicly known technology and the result of the substitution does not affect the quality and quantity of the result in any substantial way.

However, if a certain scientific or technological achievement appears to be a mere formal substitution of some well-known current technology but the result of this change corrects some misconception in the present technology and solves some longstanding technical problem and causes a substantial improvement in the quantity and quality of the product, then we can no longer view this invention as technologically equivalent to current technology, despite its simplicity and commonplace form. This is because a subtle innovation often contains significant and creative invention, and examples of this abound in history.

III. Sophistication of Invention

Sophistication is an indicator of the technological value and standard of the invention. Because scientific and technological development is a conflicting movement of inheritance and breakthrough, an invention must originate from current technology and surpass it, and the degree of advance must also reach a certain level. The judgment of this level should be left with experts in the field. The evaluation of actual results should of course be conducted by an evaluation committee consisting of representative and authoritative specialists.

Qualitative judgment of whether an achievement is more advanced than current technology is not really difficult. The term "advanced" here includes: 1) advanced in technical principle, 2) advanced in technical construction, and 3) advanced in technical results. But on the other hand, judging whether a certain achievement is advanced enough to be qualified as a major scientific and technological achievement and reaches the level of an invention is a rather complex issue. Here one should make a specific analysis based on the characteristics of different inventions. According to the nature of invention there are fundamental inventions, applied inventions, and general improvement inventions.

A fundamental invention is the material application of the newest scientific theory and often opens a new era. Examples of the transistor, the laser and the superconductor. In appraising a fundamental invention, one should recognize its advanced nature and judge its technological value from a practical and long-term point of view, and not be restricted by the narrow view of current technology and a single economic viewpoint.

An applied invention is the product of the transfer and proliferation of a fundamental invention into various special fields, such as the application of the laser and the superconductor in a technical field. Here one should distinguish whether the application is a simple transfer or modification or is a creative application. Generally speaking, only scientific and technological achievements with sufficient sophistication both vertically and horizontally can be regarded as having reached the level of an advance.

An improvement invention is generally a modification of an existing invention through the combination of already known technologies. Comprehensive analysis should be made regarding its separateness from other technologies, subject nature, degree of difficulty in the combination, practical impact, and technical and economic value.

IV. Applicability of Invention

Practicality is the only standard for testing the truth; it is also, of course, the testing standard of an invention's applicability. This should not, however, be interpreted as implying that a scientific or technological achievement is practical only after years of actual use. Because if this were the case, it would inevitably impede the birth of many superior inventions. Implementation and practical production are one form of proof of practicality; experimentation and other indirect proof deduced and concluded from technical implementation are also proof of applicability. The important issue here is that an applicable scientific and technological achievement must satisfy the following conditions: 1) consistent with scientific principles, 2) possessing implementation conditions, and 3) satisfaction of social needs.

In the meantime, to gain a proper understanding of the invention applicability, one must also use the dialectic viewpoint and clarify the following points theoretically: 1) Applicability and completeness. An invention not ready to be implemented (that is, an incomplete invention) is not practical, but this does not imply that all completed inventions are practical. Whether an invention is applicable depends on the possibility of its practical production. 2) Applicability and economics. Economic value and economic index are important factors in evaluating an invention's applicability, but they are not absolute. When it first comes into existence, the cost of a new product, material or technology may be very high, but its economic value improves as the product is gradually perfected. 3) Applicability and delayed implementation. Technologies that survive the challenge of long-term application are certainly proved to be of practical value, but this does not mean that inventions not yet put into practical production do not have practical value. In today's age of rapid scientific and technological development, "raising the question is often more important than solving the problem." Invention and innovation are more and more leading to industrial application. Many major inventions (especially signfiicant basic inventions) are often limited by the environmental condition, material and related fields in their industrial application, so a delay in implementation should be allowed. 4) Practicality and theoretical blindness. In appraising an invention, it is important to determine whether the invention agrees with scientific principles, but it is not important whether people understand the principle behind the invention. If someone accidently received a message revealed by nature and invented something that was proven to be really useful, then even though our understanding of the scientific principle behind the invention were lacking, this invention would be practical just the same. The fact is that the invention would still agree with the principles of science; it would be only that we were not aware of these principles at the time. 5) Practicality and benefit. An invention may have some negative effect along with its positive effect. In this case we should not dismiss the practicality of this invention lightly. In the long

process of technological development, any invention is not the end of technological development; the problem of eliminating these negative effects is itself a topic for future invention. Naturally the negative effect should be weighed against the benefits. When the adverse effect is so large that the society would not benefit from the invention, then its practicality is somewhat meaningless.

An important international trend in the question of appraising scientific and technological results and evaluating an invention patent is to treat novelty, sophistication and applicability as a whole. For our part, we should break our own ground on invention appraisal based on the scientific view and methodology of Marxism. It can be said with certainty that strengthening the research in this area will greatly enhance the prosperity of innovation and invention in China and yield more rapid scientific and technological development in China.

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SCIENTIFIC RESEARCH IN FACTORIES, MINES AND OTHER ENTERPRISES DISCUSSED

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 1, Jan 82 pp 68-71

[Article by Zhou Shensheng [0719 3947 3932] of the Administrative Office Science Committee of Wenzhou Prefecture, Zhejiang Province]

[Text] (I)

The development of modern economy and society is becoming more and more closely related to science and technology; science and technology have proliferated into various aspects of economic and social life and become indispensable factors of the development of economy and society. Marx once said: "Labor productive force is determined by many conditions, including the average skill of the workers, the level of scientific development and the extent science is applied in industrial technique, the social connection of the production process, the scale and function of production resources, and the natural conditions." (Complete Works of Marx and Engels, Vol 23, p 53) Here science and technology are clearly identified as important factors of the labor productive force. That is to say, it takes advances in science and technology to improve the workers' scientific and technological level and working skill, to improve the machinery and the mechanical efficiency, to use the natural resources sensibly, to develop the natural forces to the fullest extent, to effectively use labor statistics, to develop transportation means and to shorten circulation time.

The advances in modern science and technology are having increasingly greater effects on economic and social development. In the beginning of this century, technological advance accounted for 5 to 20 percent of economic growth and labor production increase in developed nations of the world, by the 1960's and 1970's, this ratio has increased to 50 to 70 percent. From 1977 to 1980 Shanghai textile industry has large scale increases in production, among the contributing factors, 71.4 percent are technological. The modernization construction must therefore rely on science and technology.

Marx divided the enlargement of re-production into two classes: extensive enlargement of re-production and intensive enlargement of re-production. "When the production field is extended, the enlargement is extensive; when the efficiency of the means of production increases, the enlargement is

"intensive." (Complete Works of Marx and Engels, Vol 24, p 192) The extensive enlargement of re-production relies purely on the quantitative increase in production elements, that is, the scale of production is increased by increasing labor, capital, equipment, material, and production field. In the past many comrades believed that only capital construction is enlarging re-production, they are only looking at the extensive enlargement of re-production. The intensive enlargement of re-production relies on advances in production technology, qualitative improvement of production elements, and improvement of the efficiency of labor and the means of production. This implies that current enterprises can achieve re-production enlargement through developing potential, restructuring, and improving without increasing new investments.

For this reason, the Central Committee stipulated that future economic development in China should not rely on building new plants but should rely on the full development of available enterprises and gradually switch from extensive to intensive. This is a fundamental change of our national construction policy and it is an economical and practical sound approach.

After 32 years China has achieved a fair scale and base in the construction of factories, mines and other enterprises and has formed a large rank of engineering and technological personnel. There are now 400,000 enterprises in China, the variety is complete but most enterprises have old equipment, undeveloped technology and a lot of potential. The development of available enterprises relies on the one hand improved business management and on the other hand sensible technological restructure, product quality improvement through new technology and new manufacture technique, reduced cost and consumption, increased product variety, and accelerated change-over of new products. If scientific research is to lead production construction, it must improve the technology development and promotion in factories, mines and other enterprises, bestow the enterprises with new vitality and move the national economy forward.

(II)

Science can become a direct productive force only by transforming into technology. The economic take-off of all developed nations in the world is always correlated with major new breakthroughs in technology. A member of the British Royal Society Kai-er-dun [phonetic] believed that the foundation of industry is not science but technology, industry cannot move forward without solving the technology problem. The fact that Japan rapidly developed into a major economic power after World War II is directly related to its adoption of a "build the nation on technology" policy. Although Great Britain is very advanced in science and produced a number of outstanding scientists, it has the highest number of Nobel Prize laureates in the world for its population, but because Britain did not pay attention to applied technology research and did not properly transform science into productive force to promote its industrial and economic development, the Great Britain is falling behind in economy. Judging from the experience of various nations, the enterprises of all economically developed nations pay great attention to technology development research and focus their business activity on it. These enterprises generally

use 3 to 5 percent of their production value or 15 to 20 percent of their profit to do scientific research. About 8 to 10 percent of their total employee are engaged in scientific research and these are all outstanding technical people. From 1945 to 1949 Japan was about 20 years behind the United States and European countries, the subsequent phenomenal economic progress in Japan cannot be separated from the role played by scientific research in its enterprises. Special consultant of Japan Electric Company and Ph.D. in engineering Dr Morita has said in a recent speech given in Hangzhou: "The government played some role in Japan's industrial development but most of the technological developments were made by private enterprises."

For a long time, scientific research in Chinese enterprises has received insufficient attention. There are two reasons. First of all, it is largely due to the "leftist" influence in economy and in technology. For example, in economic development attention was only focused on building new plants and starting new business and the role of the available enterprises was ignored. In scientific research attention was focused on highly sophisticated frontier science and the unpractical idea of overtaking the advanced international standard. Secondly, administrative methods were used to manage the economy, there were not enough competition among the products, the enterprises did not have enough autonomy and there was no internal driving force for the enterprises to do scientific research. In addition, China has been using the Russian system of scientific research since the 1950's, in which research organizations under the state's centralized management and enterprise research has a very small weight. In state-operated research organizations, everything is run by the state and research subjects are highly repetitious. The phenomenon of "eating out of the big pot" prevailed, research projects did not have economic accounting, and it took a long time to transform research results into productive force. In the near future the financial and material resources in China will be relatively tight but economic development urgently needs the support of science and technology. Therefore we must fully develop the technology restructure potential of the existing 400,000 enterprises. This dictates the important status of scientific research in factory and mine enterprises in the scientific research management system and makes it an indispensable part of the entire research system.

The Central Committee has now made technological improvement of the enterprises an important policy and the State Science and Technology Commission has also made technology development and promotion of factory and mine and other enterprises an important component of our science and technology development policy. But many leading comrades still lack sufficient understanding of this policy and all kinds of ideological blocks still exist. First of all there is the "iron rice bowl" concept, thinking that scientific research or no scientific research, there will always be something to eat. From the earlier experience on scientific research in factory and mine enterprises in Wenzhou prefecture of Zhejiang Province, the state-operated plants usually are worse than collective plants and large plants are usually worse than collective plants and large plants are usually worse than small plants. This is not a normal situation, state-operated plants and large plants have stronger technology base and better conditions, they should lead the enterprises in scientific research but in fact it is just the opposite. As the economic

management system improves, the "iron rice bowl" kind of thinking must be cracked. Second, scientific research is considered to be soft assignment and production is considered the hard assignment. Scientific research is thought of as the water too far away to put out a nearby fire. Some even think that when production is busy, research can wait. "Scientific research can be put off, if it doesn't work this year, there is always next year." No one looks at research from the strategic point of view. Third, people think of production development largely in terms of supply and sales. There is no comprehensive understanding of the mutual dependence of production and circulation. People fail to realize that one can have rapid enterprise production development only when the products are competitive and supply and sales are well organized, and product competition is essentially a competition in technology. Fourth, scientific research is mystified. People think of scientific research as highly sophisticated and esoteric and cannot relate scientific research in enterprises with the reality of technological improvement. When it comes down to it, all these misconceptions are due to lack of understanding of the relationship between scientific research and productive force, economy and technology, the vital significance of development of potential, improvement and restructure of the enterprises, the role of scientific research in improving production and the competibility of products, and the proper direction of enterprise research.

(III)

Doing scientific research and not doing scientific research make a big difference to an enterprise. Here are some examples from the Wenzhou prefecture:

1. Survival and development of small plants: Yongjia county radio plant is a small county-operated plant. It had a hard time getting established in July 1978 when it had only 10,000 yuan in the bank and could not afford to buy 20 jin of machine oil. It had only one kind of product and its monthly production value at the time was only 13,800 yuan. In the last two years or so, the plant stressed the role of research personnel, conducted production technology research and carried out more than 50 technology improvement projects. They experimentally manufactured 10 new products and came out of the dire situation, their production increased rapidly. In 1980, the plant had a total value of production exceeding 1.9 million yuan and made 160,000 yuan of profit. The projected 1981 value of production is 1.5 million yuan and the profit will reach 200,000 yuan. When they say "If an enterprise is to survive and develop, it must get into scientific research.", they are speaking of their experience.

2. Replacing old products: Pingyang county chinaware plant No 1 is an old plant with 300 years' history and it has been producing China bowls for 300 years with the same method. From 1974 to 1976 the plant had a loss of 300,000 yuan. In the past several years they established a technology research laboratory, made a major effort on scientific research and technological improvement, and created more than 300 new patterns and varieties. After that they have not only changed loss into gain but their production has also increased year after year. In 1979 their production value was 1.34 million yuan, 21 percent more than that of 1978. In 1980 they have completed 1.56 million yuan

of production which is 17 percent higher than the 1979 figure. The entire outlook of the plant has had fundamental changes and they are now busy meeting production assignments. As can be seen, the solution to renewal of old products also lies in scientific research.

3. Quality improvement of traditional namebrand products: Ruian County dairy product plant has been producing sweet condensed milk for 55 years and their product has been selling well on the international market. In 1977, their product was rejected because their condensed milk was found to show fat separation and thickening while in storage. The plant established a research office in 1978 to deal specifically with this quality problem. The problem was finally solved in 1979 and the solution was applied to mass production. Export has since increased and the consumption of fresh milk was reduced as well. This item alone brought in 164,000 yuan of profit in one year. Hence, traditional namebrand products also need scientific research to constantly improve their quality.

4. Development of collective enterprise: Leqing County science committee, in close collaboration with economic departments, made an effort to promote scientific research and technological improvement in collective enterprises. Just the 64 collective enterprises under the second light industry bureau have developed and put into production 23 new products in the last 2 years. Eleven of those have entered the international market and created 7.88 million yuan of foreign exchange for the state. Moreover, 193 new varieties, patterns and packages were experimented and put into production, thus stimulating a number of enterprises on the verge of folding or with minimum profit. The level of production technology was rapidly improved and the whole situation was quickly changed for the better.

In a word, scientific research in enterprise has many advantages and great effects. First of all, research is the center of potential development, improvement and restructure and is an inevitable path to the survival and prosperity of enterprises. It speeds up the pace of enterprise modernization and the entire process of industrial development. Secondly, the expenditure comes from within the enterprise and it saves the state great amounts of financial resources. It takes little investment and yields great economic benefits. Thirdly, the research topics come from production and the results are turned back into production. It facilitates timely promotion of research results and shortens the time required to transform research results into productive forces. Fourthly, technological force, equipments, and experimental facilities of the factories, mines, and other enterprises can be fully used. Finally, research helps the enterprises to train their technological ranks.

(IV)

Based on the experience of research effort by enterprises in Wenzhou prefecture in the last two years, we believe the following items should be stressed if we are to do a good job in promoting scientific research in the enterprises.

1. The direction of enterprise research should suit the enterprise in question and emphasize problems at hand. Import, promotion and application should

be stressed to solve urgent technological problems of the enterprise in question. Scientific research should serve potential development, improvement and restructure.

2. Properly select research subjects by following these criteria: (1) research should be in the right direction, (2) pay attention to economic benefits, (3) use the resources sensibly, (4) conserve energy, (5) combine long term and short term goals, pay attention to technological reserve. The objectives should be developing new products for the enterprises, improving old facility and old manufacture technique with new technology, improving product quality and strengthening the competibility of the products.

3. Through research contracts and research-production combination, closely collaborate with institutes of higher learning, research institutes and large plants and mines. This practice will on the one hand let each unit develop its strength and let small plants overcome their difficulty of insufficient technological force and information and on the other hand helps the transformation from research results to productive force.

4. Stress intelligence investment and development. Improve technical training, make sensible use of currently available technological personnel in the enterprises, pay attention to experienced and self-taught talents, actively attract talents, hire retired technical staff and old masters as consultants.

5. Put information work in order. We should not only pay attention to scientific and technological news but also market economic information. Scientific and technological staff may get ideas from domestic and foreign academic papers, exhibitions, samples and photographs. The purpose of engaging in information work is to select and introduce appropriate technologies for the development of our own enterprise. Imported technology should be digested, restructured and improved.

6. Establish the necessary organizations. The enterprises should concentrate their technological force and individually or collectively establish scientific research organizations such as research institute, research (design) office, and scientific research group (experiment group, technology improvement group). We should pursue the substance and not the style. The research personnel should be relatively stable to ensure continuity, avoid using research staff as "fire fighters." There should also be a fixed place for experiments (experimental shop), and certain means for experiment and equipments and instruments. We should adhere to thrifty and frugality and should not place undue emphasis on things that are big and foreign.

7. Attention by the leadership is of key importance. Administrative departments in finance and in technology should be matched closely to give research activity the proper concern, support and specific guidance. The enterprise leadership should place technology development and promotion on important agenda, strengthen the ideological and political work, provide timely assistance to overcome specific difficulty and treat scientific research like production duty.

Technology development and promotion in enterprises is after all a new endeavor, further exploration and consolidation of experience are needed. Many problems are waiting to be investigated and solved. Clear stipulation in policy and support are especially needed. To name a few items in this area:

1. The enterprises are mainly responsible for their scientific research expenditure. Possible avenues are (1) take it out of production cost, (2) funds may come from capital for developing potential, improvement and restructure or from equipment renewal capital, (3) technical service income, (4) after the enterprises are given more autonomy, research funds may come from enterprise foundation or from the portion of profit retained by the enterprise, and (5) special project loan may be applied for major projects.

2. Material needed for scientific research may be included in the enterprise supply channel. Major projects may be appropriately supplemented by material department, and equipments and instruments may be supplied by scientific instrument department.

3. Financial departments should provide policy support in the area of loans, taxes, and pricing. For example, low interest loans may be provided to enterprises for scientific research, new products may be granted tax free or reduced tax status for a given period of time, and enterprises may be allowed to set their own price for new products and sell their products on the market with the approval of price department.

4. Personnel and labor departments may provide assistance in attracting and discovering talent and in the sensible use of personnel. Technical staff transferred into collective units should be treated equitably. Enterprises should be allowed to hire part-time research staff from institutes of higher learning and research institutes. Personnel in enterprise research organizations (including technical cadres and experiment workers) should have production staff classification and enjoy the same benefits as shop workers.

Technology development and promotion of factories, mines, and other enterprises is a new service. Its development will tie science and technology closely with economic and social development and it is showing more and more vitality in promoting the industrial construction of China.

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PROBLEMS IN DEPARTMENTAL STRUCTURE OF S&T RANKS AND THEIR SOLUTIONS

Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese No 5, 20 Oct 81 pp 39-41

[Article by Dai Guangqian [0108 0342 0467] of the State Council Science and Technology Cadres Bureau]

[Text] Economic adjustment has two parts: one is the rational reorganization and unification of economic structure, and the other is the technical improvement of old enterprises. Both are closely related to the structure of S&T ranks. A rational economic structure calls for a rational structure of S&T ranks. Without rationally structured S&T ranks, the effort of technical improvement cannot succeed.

"Departmental Structure" of S&T Ranks

According to a report submitted to UNESCO by the State Scientific and Technological Commission, there are five parts to the Chinese S&T ranks: the Academy of Sciences and its local branch institutes; departments in the State Council and local research and design institutes; research organizations of colleges and universities; S&T ranks in plants, mines and villages; and S&T ranks in defense. The departmental structure discussed in this paper is not made up according to this division; instead, we are investigating the division and organization of S&T ranks in the major departments of the national economy. We shall emphasize study of the quantitative structure of engineering and technical personnel in major industrial departments.

In 1978 there were approximately 4.35 million scientific and technological staff members in the national units. The distribution is approximately 40.6 percent (of the total S&T personnel) in culture, education and health departments; 8.2 percent in agriculture, forestry, water conservancy and weather departments; and 27.7 percent in industrial departments. This is consistent with the overall situation in China, where the 1 billion population requires basic educational and health service, agricultural and forestry lack technical personnel, and industry is reasonably developed.

In 1978, more than half of the 1.571 million engineering and technical personnel in public units were concentrated in industrial departments, although capital construction, telecommunications and transportation departments each

had a certain number of engineers and technical people. A total of 851,000 were in industrial departments, 14.5 percent of which were in light industry and 85.5 percent in heavy industry. Moreover, almost two-thirds (64.2 percent) of the engineers and technical personnel in industrial departments were concentrated in two areas: machine building and metallurgy.

The Present "Departmental Structure" of the S&T Ranks Is Not Meeting the Needs of National Economic Readjustment

For a long time the economic construction in China has followed the route of heavy structure, the priority of capital goods development was stressed, and the production of consumer goods was ignored. The production of capital goods was "self-serving" and kept going around in the heavy industry circle, while service for consumer goods production was neglected. From 1949 to 1978, the growth in heavy industry was more than 90-fold, light industry grew 20-fold, and agriculture grew more than twofold. The development of capital goods production far exceeded the development of consumer goods, and an anomaly resulted. Not only did supply fall more and more behind demand in capital construction, industrial production and market supply, but the national economy turnover was sluggish, production and construction were both highly wasteful, and the economic efficiency was very poor. If this situation were allowed to continue, not only would it be impossible to improve the people's standard of living, but production and construction would both run into great difficulties. The ultimate goal of our national economic readjustment is to begin with the current situation in China and reorganize the economic structure rationally, gradually shift our economy from a passive to an active position, and pave the way for a Chinese-style modernization. The present task is to readjust the production from a heavy structure gradually to a sensible light structure.

The production of consumer goods is an integrated reprocessing procedure. Many academic disciplines and technologies are involved in this process, from material supply to reprocessing to production and packaging. The development of consumer goods production is relying more and more on science and technology. At the present time, the light industry S&T effort is very inappropriate for the development of light industry, an important field in consumer goods production. One of the important reasons is the lack of S&T personnel in the light industry departments to match the task. As far as the departmental structure in S&T ranks is concerned, the "heavy structure" in engineering and technology has not been changed very much.

As a result, the S&T force in light industry turns out to be inadequate everywhere, and the situation is in sharp conflict with the current production development. For example, bicycles produced by the Beijing Bicycle Plant are slipping year after year in the national bicycle appraisal, and yet demand for production keeps rising. Out of 3,300 workers at the plant, only 34 are technical personnel, and the entire plant has no specialist in paint baking, electroplating or welding. Another example is that Beijing produces 2 million dozen soft drinks and the supply is still behind demand. This is partly because the only efficient bottling machine, moved in from Shanghai, is of 1930 vintage and often breaks down; it sometimes runs and sometimes quits and has never been properly fixed. Some say this is because of a long unresolved

technical problem in pressure. As for the development of convenient food for solving the eating problem on the new long march, even more technical difficulties are encountered. No wonder comrades in light industry departments have said: "We can launch our rockets into the sky and we can recover our satellite, but for the cover of a light package, we still have to buy a foreigner's patent."

According to the requirements of national economic readjustment, the industrial production mainly of the machine building industry should be decreased, then the production of the steel industry should be decreased by a smaller scale. These two departments happen to have the highest concentration of engineers and technical personnel. As heavy industry changes its object of service, although some engineering and technical personnel have joined various technical duties in light industry such as equipment renewal, technological improvement, and production, many leaders and technical staff still believe that this is a matter of expediency and not the norm, and therefore pay little attention to gaining new knowledge and improving technical standards in these fields. As a result, the heavy structure of the engineering and technical ranks has not been changed substantially. This situation is still a far cry from the needs of national economic readjustment, and particularly from the final goal of the national economic readjustment.

The Reasons for the Incompatibility of "Departmental Structure" in S&T Ranks and the Current National Economic Readjustment

The most fundamental reason leading to the problem described above is that the development of the S&T ranks in China is suited to the needs of the heavy structure development in the national economy and does not conform to the current readjustment of the national economy. It is a historical factor.

Before liberation and under the reactionary ruling of the Kuomintang for more than two decades, the higher education only produced 180,000 graduates. After these engineering and technical people left school, their first concern was to find a job, and many people were forced to give up their specialty because of the job problem. At that time the liberated region did not have a modern industrial base, work in many other areas urgently needed large numbers of revolutionary cadres, and many special and technical people who participated in the revolution had to work at other posts. Up to liberation, China had only 50,000 scientific and technological personnel, which is hardly a team, not to mention a reasonable structure.

After liberation, starting in 1953 and 1954, China began its large-scale economic construction centered on 156 engineering projects under Soviet aid. Heavy industry was given priority in order to insure the equipment and material needed in agriculture, light industry, communication and transportation, and defense. This was entirely necessary and correct. At the time attention was also given to the equilibrium of coal, oil, electricity and transportation and to the coordinated development of heavy industry, light industry and agriculture. To meet these needs, the engineering and technology ranks grew from 130,000 in 1952 to almost 500,000 in 1957. Because the average annual growth of heavy industry was almost three times that of light industry, it

was natural for the engineering and technology ranks to become a heavy structure. The distribution is shown in the table below.

After the beginning of the Second 5-Year Plan the development of heavy industry was still excessively stressed; the priority given to heavy industry was even simply interpreted as priority in developing the steel industry, and the national economy was planned centered on steel production. This practice restricted and hampered the development of light industry and agriculture, and caused a long-term short supply in the fuel power industries of coal, electricity and oil; the construction materials industry; and communication and transportation enterprises. Without a proper balance the entire national economy could not develop smoothly and even encountered great difficulty. During the second 5-year plan, the development pace of heavy industry was five or six times that of light industry. To meet this situation, various schools naturally stressed the needs of heavy industry in their training of engineering and technical people. Take the engineering majors in colleges and universities between 1957 and 1962, for example: the average growth of metallurgy students in school was 24.9 percent, whereas the average annual growth of the number of students majoring in light industry specialities was only 12.2 percent. Correspondingly, the average annual growth of engineering and technical staff in metallurgical industry was 18.9 percent, and the textile industry had only 5.7 percent. Not only was the rate of increase slow for light industry technical people, but there were also fewer specialty categories. As late as 1980, only 46 of the 453 specialities in 15 engineering categories in higher education were directly related to the development of light industry and textile industry, or only 10.15 percent. Thus, the engineering and technology ranks in industrial departments became oriented more and more to heavy industry in the long process of development.

Next, because of the influence of the "leftist" thought, intellectuals were treated improperly and errors in management gradually locked technical staff into departments, regions and units, and made them immobile. The departmental structure of the S&T ranks has become a "rigid structure." Hence, even though the national economic structure has begun to readjust, the structure in S&T ranks is still not turning around.

In fact we were not this rigid in the early period after liberation. In 1952, when the war to resist U.S. aggression and aid Korea was going on, it was decided by the Political Council of the central people's government that 1,000 technicians and 4,000 technical workers in aviation, automobile and tank engineering would be drafted from various large administrative prefectures and departments of the central government to strengthen the defense industry. In 1953 when China launched its large-scale economic construction, RENMIN RIBAO published an editorial entitled "Let Technical Specialists Man the Posts Most Needed in Economic Construction," which emphasized that "without a sufficient number of specialists and technical people, it would be impossible to transform China from an agricultural country into an industrialized country" and pointed out the necessity to solve the problem of irrational use of special and technical personnel. In the next year, in an attempt to meet the urgent industrial construction needs of the time by concentrating resources and first solving the rational use of industrial technological cadres in a short time,

the Political Council of the central people's government further decided to register, concentrate and assign those industrial technological cadres in 14 specialties--including civil engineering, architecture, mechanical engineering and electrical engineering in offices above the county level, state-operated enterprises, private and public jointly operated enterprises and institutes of higher learning nationwide--who were improperly assigned or were unable to put their knowledge to good use, to major industrial construction posts. These practices met the economic construction needs of the time and reflected the "flexible structure" of the S&T ranks. It has been more than 20 years since that time and the S&T ranks now are quite different, but today it is exceedingly difficult to transfer special and technical personnel even among research, production and teaching branches in the same department, not to mention between different departments. It is even more difficult for heavy industry and military industry to provide systematic, organized and directed technical assistance for light industry and textile industry. If this situation were to continue, it would be very difficult to readjust the national economy.

Problems To Be Solved in Changing the Departmental Structure of S&T Ranks To Suit National Economic Development

Because the departmental structure in S&T ranks was formed over a relatively long period of time, it will not be easy to change it; it may even take longer than to change the economic structure. In order to meet the needs of national economic development, we should begin solving problems in three areas: planning, implementation, and methodology.

In the long run, the "departmental structure" in S&T ranks should be studied in terms of national economy, science and technology, education and even the unified development plan of the entire society in all provinces, municipalities, and autonomous regions in the nation, and corresponding plans should be formulated. This would require the collaborated effort of departments in charge of economy, education and science and technology; it would be impossible for one single branch to solve the problem.

For now, we must take some emergency measure to meet the needs of economic readjustment. In order to strengthen the S&T ranks in light industry, there are three things we must do. First, great effort must be made to train reserves, existing institutes of higher learning in light industry must be run well, and secondary vocational schools must be selectively reinforced. Second, technical professional titles should be given to those workers who have acquired the corresponding technical level through learning and through practice, and some of them should be selected to reinforce the scientific research team. Third, step by step some members of the technical force should be pulled from heavy industry and military industry departments to strengthen and improve the S&T ranks in light industry. This can be done either through some workable arrangement of short-term collaboration and joint employment or through various technology transfers or "directed flow of knowledge."

From the academic research point of view, the methodology problem in scientific and technological structure needs to be solved. It is particularly important

to begin establishing a qualitative relationship, even an empirical one, between the economic structure and the S&T ranks in China and determine some reasonable quantitative parameters. These are an important basis for formulating plans and policies. Regarding the micro aspect, when a new enterprise was being established in the past, these parameters were frequently reflected in determining the number of staff based on the scale of the enterprise and the degree of difficulty of the technology. (According to the Ministry of Textile Industry 1963 standard of fixed number of staff, 22.2 engineering and technical personnel were required per 10,000 spindles in the cotton textile industry, and 57 were needed per 100 textile machines in the hemp textile industry.) Regarding the macro aspect, in order to assess the development and planning needs of S&T ranks in 1960, the office of the then central scientific and technological cadre planning group extensively studied the relationship between engineering technical cadres and industrial production value and rate of employee increase for the period 1953 to 1959 in China, and for the period 1926 to 1936 in the Soviet Union. The preliminary conclusion was that for each 100 [percent] increase in the total value industrial production, the number of engineering and technical cadres should be increased by 90 percent, staff and workers by 40 percent, and production workers by 50 percent. This is the most specific parameter we have seen so far.

We should find the method and establish a mathematical model through our own study. Then we can make an analysis of the departmental structure of the Chinese S&T ranks more scientifically than is possible at present.

Footnote: Light industry in this article refers to large light industry, i.e., all industries that produce consumer goods. That is to say, along with systems belonging to the Ministry of Light Industry and the Ministry of Textile Industry, it also includes portions of other industries that produce consumer goods, such as electric meters of the First Ministry of Machine Building and part of the civil products (television sets and semiconductors) of the Fourth Ministry of Machine Building, food and clothing of the Ministry of Commerce, and production departments of some commune and brigade enterprises in the Ministry of Agriculture.

(Edited by Ke Ren [0668 0086])

9698
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STRUCTURAL OPTIMIZATION OF S&T PERSONNEL IN THE CHEMICAL INDUSTRY

Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENOLOGY AND MANAGEMENT OF SCIENCE AND TECHNOLOGY] in Chinese No 5, 20 Oct 81, 00 42-44

[Article by Wu Shimin [0702 0013 2404] and He Sheng [0149 3922] of the Science and Technology Bureau, Ministry of Chemical Engineering: "Analysis of the S&T Ranks in the Chemical Industry"]

[Text] An important task in the management of science and technology is the structural optimization of S&T ranks. We have recently made preliminary investigation and analysis of the personnel structure in research units under the direct jurisdiction of the Ministry of Chemical Industry. We wish to present some of our initial views as a reference for study.

I. Ratio of Research Personnel and Support Personnel

To a certain extent, the ratio of research personnel to support personnel reflects the effectiveness of using the research personnel. Although research personnel shoulder the main responsibility of scientific research, they cannot play their role fully without the assistance of a certain number of support staff. According to some foreign studies, support staff can save 30~40 percent of the time unreasonably required of the scientists and increase the results by 50~75 percent. In the chemical research circles in the United States, the ratio of research staff and support staff is approximately 1 : 2.5, and in Soviet Union this ratio is 1 : 3.

In China the scientific research system and management system are different from those in foreign countries, and the research units in industrial departments are also different from those in the Academia Sinica system. For the sake of comparison and discussion, we reviewed the situations in China and abroad and divided the personnel in the chemical industry research units into three categories:

The first category is scientific research staff, i.e., technical staff directly involved in scientific research activities. The second category is support staff, including research management, maintenance, equipment, information, and reference personnel directly supporting the activity of research staff and experimental technicians. The third category is logistics services staff, including staff of administrative management and rear service departments.

Table 1 below shows the personnel composition of some of the research units under the direct jurisdiction of the Ministry of Chemical Industry having 1,000 or more employees.

The data in Table 1 showed two problems:

First, the average ratio of research staff to experiment technicians is 1 : 0.8, so the number of experiment technicians is not quite sufficient. Because experiment technicians are support staff directly engaged in research activity, an insufficient number of experiment technicians invariably forces the research staff to spend a lot of time and effort to do the work originally intended for support staff. Statistics show that many research staff in some units spend one-third of their time every year working as operators in shifts. A systematic training and replenishment of experimental operators for the first line of scientific research is therefore essential.

Table 1.

Unit	1	2	3	4	5	6	Total
Total number of staff	3460	1790	1530	1480	1360	1080	10700
Research staff Number	680	590	520	250	450	360	2850
Percentage of total staff number	20	33	34	18	33	34	29
Supporting staff Number	1620	830	670	420	740	450	4730
Number of experiment technicians included	860	480	280	120	420	220	2380
Service staff	1160	370	340	810	170	270	3120
Ratio of research staff and experiment technicians	1:1.3	1:0.8	1:0.5	1:0.5	1:0.9	1:0.6	1:0.8
Ratio of research staff and support staff	1:2.3	1:1.4	1:1.3	1:1.7	1:1.6	1:1.3	1:1.6

Second, research staff make up only one-third of the staff and workers, and the ratio of main body research staff and research support staff is only 1:1.6 (in foreign countries this ratio is 1: 2~3). An important reason

leading to this discrepancy is the "small but complete" practice for a long time. In foreign countries the supply of scientific instruments and the rear services of daily life have been institutionalized, but in China these are entirely the burden of the research units themselves, and the research units have to assign substantial manpower to these chores; in some cases it takes as much as one-third or one-half of the total number of staff and workers. To change this situation, we must first break away from the "small but complete" situation and gradually socialize the supply of scientific equipment and rear services for daily living. Moreover, production shops not of a research nature should not be in research units. The main avenue to increase income should be a compensated transfer of the research results. Finally, the organizational structure should be simplified, and some of the administrative personnel should be systematically and gradually transferred to research management.

II. Allocation of Research Staff Specialties

In modern scientific research, the collaboration and allocation of many disciplines and specialties are becoming increasingly necessary. Therefore a proper ratio of staff in various specialties should be maintained in the composition of a research team, taking into account the needs in each stage of work on basic research, applied research, and development research. In industrial research units primarily engaged in applied research, it is especially necessary to allocate a certain ratio of engineering researchers.

Table 2 shows the specialty composition of research staff in the Du Pont Company and the Dow Chemical Company in the United States and in some research units in China directly under the Ministry of Chemical Industry.

As can be seen from Table 2, engineers make up a substantial percentage of the research staff in the Du Pont Company and in the Dow Chemical Company in America, respectively 34 percent and 25 percent of their total research staff. In research units directly under our Ministry of Chemical Industry, chemical engineers only make up 9 percent of the total; even combined with mechanical engineers, there are only 20.4 percent engineers, 5~15 percent less than the American companies. As to the ratio of mathematics and physicists, they are two~four times less than in the two American companies. The lack of engineering staff, chemical engineers in particular, is precisely the reason why our industrial research units often lack engineering concepts and why research results often linger in the "sample, display unit, gift" stage and cannot be rapidly put into production. Similarly, the shortage of mathematicians and physicists is precisely the important reason that many industrial research units are unable to develop and apply basic research and cannot improve their research standard.

We therefore believe that, first of all, the institutes of higher learning should include new specialities and train different engineering specialists, and research units should be given the priority to choose from the graduates. Second, some personnel engaged in skilled study should be systematically trained to carry out engineering research. Third, collaboration or joint

Table 2.

Specialization \ Unit	Dupont Company		Dow Chemical		Some institues directly under the Ministry of Chemical Industry in China	
	Number of staff	Percentage	Number of staff	Percentage	Number of staff	Percentage
Number of research staff	3796	100	2000	100	4110	100
Including: Chemists	2111	55.6	868	43.4	2378	57.9
Chemical engineers	822	21.8	503	25.3	369	9.0
Medical engineers	468	12.2			468	11.4
Physicists, mathematicians	200	6.0	63	3.1	56	1.4

operation among research units, institutes of higher learning and plants should be highly encouraged so that each can fully develop its advantages and gradually form a science-technology-production consortium.

III. Percentages of Senior, Intermediate Level and Junior Researchers

In other countries, the composition of senior, intermediate and junior researchers in the S&T ranks forms a "pagoda" structure. This type of structure properly reflects the continuity of various levels of researchers and the regularity of advancement and promotion. It also shows the central role played by senior and intermediate researchers.

In research units under our Ministry of Chemical Industry, the structure of senior, intermediate, and junior technical staff is "drum" like, or large in the middle and small at the two ends. Table 3 shows the actual percentages.

Table 3

Total Number of Research Staff	Senior Researchers: Number of People	Senior Researchers: Percentage	Intermediate Level Researchers: Number of People	Intermediate Level Researchers: Percentage	Junior Researchers: Number of People	Junior Researchers: Percentage
4110	53	1.3	2441	59	1620	39.7

Note: In an actual industrial research unit, a senior researcher refers to a senior engineer, an intermediate researcher refers to an engineer, and a junior researcher refers to an assistant engineer or a technician.

As can be seen from Table 3, the percentage of senior researchers in chemical industry research units is too low. Up to now most of the 16 professions in the chemical industry have not formed their own technological authority or academic leadership. In addition, a great majority of the senior researchers are assigned to leading posts; each person takes on too many jobs and becomes bogged down in administrative duties and cannot develop his technological specialty after losing touch with the actual practice of scientific research for too long.

The structural composition above also reflects the case of an over-concentration of intermediate-level research staff in research laboratories and even in research groups. Because researchers generally have the desire to create the need for self-fulfillment, the excessive concentration of the same level of researchers undoubtedly restricts the development of their intelligence.

We believe that effective measures must be taken as soon as possible to free the senior researchers from the burden of administrative duties and let them return to the first line of research and direct and advise the research. In the meantime, the training and selection of a group of technological point men should be speeded up and an academic and specialty leadership formed. In addition, the policy of personnel exchange should be consistently followed, and some of the overly concentrated intermediate-level researchers should be transferred to departments short of staff so that they can play their role and speed up their achievements.

IV. Age Composition of Research Staff

The age composition of a research team shows the vitality, creativity and the tendency toward prosperity or decline of the team. In the research units directly under the Ministry of Chemical Industry, 96 percent of the researchers have been trained in New China. However, because of the 10-year turmoil, this team has shown signs of aging and lack of continuity. Table 4 shows the age distribution of research staff in these units.

Table 4

Age Interval	Below 35	36-45	46-55	56-60	Above 60
Percentage	14	62	20	8	1

From Table 4 we can see the following features;

First, 62 percent of the research staff are in the best (35-45) age bracket for scientific invention. They have had systematic education in basic knowledge and have gained working ability from 10-20 years of actual practice. They have become the main force in various research units. However, they lack the knowledge of modern science and technology because they have not received timely professional retraining. It is therefore very important to place the emphasis of staff training on these middle-aged staff, whether concerning the present situation or the development of science and technology in the next 10 years.

Second, Table 4 also shows a very small percentage of young researchers--only 14 percent. It has been estimated that 10 years from now the average age of the research staff will be 44, still 2 years older than the present average of 42 even if 5 percent of the current research staff is replenished by new graduates every year beginning in 1981. The number of people in the best age bracket will decrease from the present 60 percent to only 20 percent. We should therefore on the one hand speed up the training of new blood and on the other hand create favorable conditions for the middle-aged and young research staff in terms of learning, working and daily life so that they may prolong their research youth as much as possible.

(Edited by Chen Deyuan [7115 1795 3293])

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MANAGEMENT OF AGRICULTURAL SCIENTIFIC, TECHNICAL PERSONNEL STUDIED

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 1, Jan 82 pp 27-30

[Article by Zhu Xinmin [2612 2450 3046] of Anhui Agricultural College: "A Preliminary Study of the Management of Scientific and Technical Personnel in Agriculture"]

[Text] The success of agricultural science research generally depends on three factors: personnel, resources and topics. Among these three factors, personnel has a decisive significance. Technical personnel in agriculture includes research personnel, teaching personnel, technology extension personnel, technical management personnel and technical workers. Their main duties are the research and application of agricultural science technology, the development of agricultural production and the promotion of agricultural modernization. In this article we present a preliminary analysis of the basic situation of agricultural technical personnel in Anhui, explore the main avenues for improving the management of technical personnel in agriculture and seek the basis for readjusting and managing the agriculture technical rank.

I. Labor Results of Agricultural Scientific and Technical Personnel

Technical personnel in agriculture are the pioneers of agricultural scientific knowledge, they engage in a creative effort that plays an active role in agricultural production development. Counting from the early 19th century when agricultural research institutes were first established, European and American capitalist countries have approximately 100 years of history in agricultural science research. Over the last century the development of agricultural science has always been closely related to the development of agricultural production. According to an analysis made by the Americans, agricultural production in the United States increased by 81 percent and production efficiency increased by 71 percent in the 1929-72 period. This is attributed to the promotion of agricultural research and technology. In China the gross value of agricultural production in 1978 was 2.4 times that of 1949, this increase is also closely related to the promotion of improved crop variety and advanced technique. According to statistics of the Chinese Academy of Agriculture, the planting of cross-bred rice and increased fertilizing increased the 1980 national rice production by 7.8 billion jin which is more than 1/3 of the total national increase in grain production. In 1982 China patented the cross-bred rice and for the first time transferred agricultural technology overseas. China

is now exporting to the United States and will be exporting rice to Italy, Brazil, Portugal and Spain to contribute to the world rice production. Anhui Province planted 1.82 million mu of cross-beed rice and production increase due to this practice alone was 270 million jin. In the future there will still be some population increase and farmland will decrease some; it will be more and more difficult to increase the production level and the role played by agricultural technical personnel in production development will be especially significant.

II. Present Status Analysis of Technical Personnel in Agriculture

Anhui Province is an agricultural province with an agricultural population of 88.9 percent. Farm labor and other resources of Anhui are among the 10 highest of provinces in China and yet its production level is not among the 10 highest. Agricultural technical personnel in Anhui therefore have a difficult task to catch up with advanced levels in China and then proceed to achieve modernization. But the current status can be described as not too strong.

Quantity Is Low

(1) Based on the 1978 general survey data, Anhui Province has 9,949 technical personnel in agriculture, this is 7th in the nation and its percentage of the total agricultural population in the province is 2.3/10,000. The national average in China is 3.6/10,000, in Japan it is 18/10,000 and in the United States it is 21/10,000. Comparatively, the ratio in Anhui is on the low side, and in terms of actual need it also appears to be inadequate. On the average each commune has only 3.4. If the 949 science research personnel were taken out, there would be 9,000 left. One-third of those are working in administrative departments of agriculture, forestry and population at provincial, regional or county level. Only 6,000, or two in each commune, are working at ward and commune agricultural technology stations. This situation cannot satisfy the actual need of technology promotion.

(2) There are 949 agricultural researchers in Anhui Province, or 0.23 per 10,000 agricultural population while the national average is 0.27/10,000. These people are distributed in over 100 research units at the provincial, regional and county level, less than 10 in each place. Separately, provincial institutes have about 19, regional institutes about 10 and county units have less than 5. Approximately two-thirds of these people are directly engaged in topical research and, according to the provincial institute of agriculture science, each topic has slightly over two researchers and some of them manage more than two research projects.

Quality Not High Enough and Manpower Not Strong

(1) In terms of education, 60.8 percent of Anhui's science research personnel have college degrees, out of these less than 10 people have graduate degrees; 9.9 percent came from college-level technical schools and 29.3 percent graduated from middle-level technical schools. Separately, 58.2 percent of people

in provincial level institutes have college educations, for regions (municipalities) and counties the figures are respectively 65.2 percent and 59.6 percent.

(2) In terms of technical levels, the provincial institute of agriculture has 2.2 percent of its staff above the level 7, 11.5 percent between levels 8 and 10, 32.4 percent between levels 11 and 12 and the rest 18.7 percent are level 13. In regional (municipal) institutes of agriculture, 8.9 percent are level 9 and 10, 19 percent are levels 11 and 12 and 25.3 percent are at level 13. At the county level, 8.9 percent are of levels 11 and 12, 31.8 percent are of level 13. In Anhui there are very few senior personnel and most of them do not run projects.

(3) In terms of age, research personnel are on the old side and there is a continuity problem. The average staff age at the provincial institutes is 42.7 and 62.3 percent are older than 40. The average age at regional (municipal) institutes is 39.6 and 56.1 percent are over 40. At the county level the average is 37.4 and 43.1 percent are over 40. Principal researchers above the assistant level have mostly passed their best years (25 to 45 years old). Senior researchers in Anhui are older than 70 years, middle-level researchers are over 40 and their average age at the provincial institute of agriculture is 48.1 which is 20 ~ 30 years older than their foreign counterparts. The aging phenomenon is very serious.

(4) In terms of academic leadership, the aging phenomena and knowledge are relatively acute because of the 10 year turmoil. Authoritative academic leadership in research institutes, laboratories and groups has not yet completely taken form and project selection, design, implementation, consolidation and evaluation are in need of strong guidance.

(5) In terms of the basic function of science research, there were less than 40 independent agricultural research units in Anhui before the Cultural Revolution. Now there are over 100 and both the number of institutes and the number of researchers have doubled; more than half of the staff came from other units and departments, a few of them are graduates of the later period of the Cultural Revolution. Therefore, some of the staff lack actual experience in agricultural science experiments.

(6) In terms of personnel structure, there are a total of 3,389 staff and workers in Anhui's agricultural research units. The ratio of administrative cadres, technical cadres and workers is 1 : 2 : 4. In provincial institutes of agriculture the ratio is 1 : 3 : 4, in regional (municipal) institutes the ratio is 1 : 3 : 5 and in county institutes it is 1 : 2 : 5. The figures in Jiangsu Institute of Agriculture and Zhejiang Institute of Agriculture are respectively 1 : 5 : 4 and 1 : 4 : 5. In comparison, there are too many workers and not enough technical cadres. In terms of the specialty and field of the technical personnel, more than 90 percent are in crops, horticulture, sericulture, livestock, aquatic production, and plant protection, 91 percent are in provincial institutes of agriculture, and less than 10 percent are in agricultural economics, mechanical engineering and foreign language. Almost

100 percent of the regional and county institutes are in agriculture. These percentages show that the structure of agricultural technical personnel is not favorable to interdisciplinary combination.

In short, Anhui Province has sizable ranks of agricultural technical personnel and they are relatively active in learning science and technology. If management can be improved to take advantage of the situation, the agricultural technical personnel in Anhui can play a major role in studying and promoting agricultural technology and developing agricultural production.

III. Basic Ways To Improve Personnel Management

The heart of management improvement of agricultural technical personnel lies in the continuous improvement of ability, adjustment of structure and development of the initiative of the technical personnel so that they can be more effective in the process of production development and agricultural modernization. In a sense, the process of agricultural modernization is a process of arming the agricultural workers with science and technology and is also a process of intellectualization of agriculture workers. Quality of the workers is of key importance in improving the productive force in agriculture. Today China is still a country with many illiterates. The intellectualization of agricultural workers should be the whole society's concern and management and use of currently available technical personnel is of decided importance in the intellectualization of agricultural workers and the build-up of agricultural production. Below, we give our unconsidered opinions regarding the improvement of personnel management.

Actively Cultivate Technology Promotion Personnel

Agricultural research units below the provincial level are largely involved with the application and popularization of research results, these units should put more efforts into popularizing research. Provincial institutes of agriculture research should devote 20 percent or more of their efforts on promotion research and popularization activity, regional institutes should put in 50 percent or more and county bureaus should devote their full effort to popularization. At present, technical staff of provincial institutes and region and county bureaus are devoted almost entirely to applied research, about 40 percent of them are doing breeding research. This situation should be changed as soon as possible. Agriculture is under the constraint of nature, arbitrary uniformity over large regions is disadvantageous, the key to popularization is at the grassroot level, communes and brigades. If each brigade were to have an intermediate level technical staff the entire province will need 30,000. If each production team were to have a junior technical staff, the entire province will need 300,000. We can therefore see that training popularization workers and enlarging the technical promotion team is an important task in personnel management. To cultivate promotion personnel we need to open up the avenues for learning, in addition to current colleges and schools, villages should open agriculture middle schools, and research units at the provincial, regional and county levels should also assume the duty of personnel training and serve agricultural production with their research results and personnel output.

Improve the Quality of Research Personnel

Agricultural research in Anhui is primarily bringing in and describing research results, creativity is only secondary. Take seed breeding, for example. More than 40 percent of the effort in the province is devoted to breeding. While only 23.5 percent of the effort is in the use of the seed stock and the selection of promising improved varieties. Furthermore, the planting area is small and relatively few [varieties] are transferred to other provinces. To rectify this situation, the main thing is to improve the personnel quality in addition to improving management. The principal goals of personnel quality improvement are:

(1) Training of academic leaders

Academic leaders are creative and experienced people in the field who can lead a group of people conducting research and development. The average age of 168 intermediate researchers in the provincial institutes is 48.1 years, but the average age of the 50 project leaders of 54 research projects in 1978-79 is 45.3 and 50 percent of them are younger than 45, the youngest one being 34. Thus, it is better to train people younger than 45 as academic leaders.

(2) Training of core researchers

Core researchers should be able to complete assignments independently, organize topical research, design research plans and consolidate experimental work. These core researchers are now all above 40. A group of core researchers should be selected among people younger than 30 and trained to solve the continuity problem.

(3) Improving the fundamental course, experimental technique and foreign language ability of researchers

Because of the aftermath of the 10-year turmoil and the aging of intellectuals, everybody has a retraining and reeducation problem. Everyone should work and learn at the same time with the emphasis properly placed.

In the training and improvement of researchers, the function of currently available academic leaders and senior scientists in each unit and region in the province should be fully developed. There should also be a systematic plan to send people to other units, other provinces and even foreign countries to learn. This effort is of strategic importance and should be implemented systematically and vigorously.

Adjust the structure of the technical rank

First of all, various academic disciplines should be in a proper proportion to facilitate in-depth and general research. In terms of agricultural research units, personnel in basic science, applied mathematics, computer technology, economics, and interdisciplinary fields are now in short supply. We should properly increase personnel in these areas according to the situation in each

unit and the percentage perhaps can be controlled at around 20 percent. Secondly, a more desirable pagoda-shaped structure should be formed through adjustment in the technical level (senior, intermediate, junior), work division (research, assistant, and support staff) and age (old, middle, and young). Third , the ratio of administrative cadre, technical cadre and workers should also be appropriately adjusted. Turn laymen into experienced personnel by training, and gradually use machines to reduce the proportion of workers. The present ratio of 1 : 2 : 4 should be gradually transformed into 1 : 5 : 4, that is, for each management person, there is 1 researcher (or leader), 2 assistants (or core researcher), 2 support staff and 3 to 4 workers.

Thorough implementation of policy and rational use of personnel

Like other technical personnel, agricultural personnel is one part of the worker class and a reliable force of our party. In the past few years the central and local governments have adopted a series of policies regarding agricultural technical personnel which have had the intended effect on mobilizing the initiative of the technical personnel. But there are still some problems which need exploring.

(1) The socialist principle of pay according to work should be adhered to firmly. Today the tendency of average-ism still exists widely among the agricultural technical workers. For units and individuals with prominent achievements in science and technology, the socialist principle of material benefit is not properly realized. In the future, job responsibilities should be made specific, and technical personnel with outstanding achievements should be given timely recognition in terms of political honor, technical job title and work compensation. The same should be done to entire departments to encourage everyone diligently to study foreign languages and fundamental theories and reach for the high peaks of science by investigating and promoting science and technology.

(2) Persist in tailored training and using one's specialty. A research outfit should be a collection of various personnel with research ability. This group should include not only specialized personnel but also general personnel; not only professional personnel but also fundamental and technological talent; not only research staff but also management staff. After a certain basic level is reached, each type of personnel should avoid the use of people with only a layman's knowledge and pretending that laymen are experts.

(3) Personnel flow problems. Personnel flow is conducive to personnel growth and science development. Personnel flow is an objective necessity, if the current job cannot make good use of a person's specialty, be it research, teaching, promotion or management, then transfer may solve the problem. Personnel circulation may be promoted in the following ways: (a) Research institutes should have the right to transfer and hire people; (b) Organize large-scale research collaboration; (c) Invite people in and send people out for professional improvement; (d) Organize visits and academic exchange; and (e) Allow project managers to select assistants and support staff.

(4) Broaden the outlet for talents. The modernization of agriculture needs agricultural technical talents in large numbers, therefore, avenues should be broadly created for talents and only the talents. In addition to cultivating talents through various channels, self-educated youth should also be encouraged. The state should establish the necessary system whereby the self-educated can be examined or evaluated by state appointed units, and after they are hired they should be treated equally. In order to prevent restrictions on talent growth by state regulations, technical personnel and technical cadre may be counted separately and managed separated.

(5) Create a favorable research environment. In order to have a fully effective technical staff, equipment, facility and library material are necessary conditions. Japanese friends recently visited Anhui and their impression of our provincial institutes of agriculture was "nice space but no nice equipment." In recent years the operating expense per person is 2,000 yuan at provincial institutes, 1,500 yuan at regional bureaus and only 1,000 yuan at county bureaus. Take away wages and various sundry expenses, very little is left, and money for purchasing equipment and library material and research project funds are in relatively short supply. If this situation is not changed, it will lead to a waste of talents, and to change this situation we must do two things: one is to increase investment and the other is to cut expenses, increase revenue, maintain priority and invest sensibly.

(6) Establish evaluation and promotion system. The state already has regulations regarding the promotion of technical personnel, but to implement these regulations properly there should also be a system.

In view of the shortage of trained personnel in China and the need to speed up the process, evaluation may be carried out every year to accelerate personnel growth. The main items of the evaluation should include professional standards, foreign language levels, research and work abilities, research achievements and work results, and contribution to and economic effect of agricultural production developments. The mode of evaluation may be a combination of examination, work summary and result appraisal. After the evaluation, proper rewards should be given according to the standard, and promotion to a commensurate technical job title should be made by the academic committee.

FOOTNOTES

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9698
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CHINA SCIENOLOGY AND SCIENCE AND TECHNOLOGY POLICY RESEARCH ASSOCIATION ESTABLISHED

Shanghai WEN HUI BAO in Chinese 14 Jun 82 p 1

[Text] At Jiuhuashan in scenic Anhui, more than 100 scienology and science and technology policy research workers conducted a heated debate on a series of important issues concerning China's science development and policy. The China Scienology and Science and Technology Policy Research Association was established here today.

Scienology is a discipline of study of the relationship between scientific and technological development and regulations of scientific research activities on the one hand, and a study of science and technology, social and economic ideology on the other hand. In 1977, the prominent scientists Qian Xuesen proposed strengthening research on scienology. A group of science and technology workers and science and technology policy workers eager to promote scienology research throughout the country began to carry out a study of this field. Now in China, there is the Shanghai Scienology Research Institute and five or six specialized research organizations; 24 provinces and municipalities have established research associations uniting several hundred professional researchers and several thousand amateur research personnel eager to promote scientific research. The Shanghai Railway Institute and other institutions of higher education are offering scienology courses. Scienology and science and technology policy has produced an unprecedented flourishing phenomenon.

For several years, China's scienology research workers have conducted research on strategy for developing China's science and technology, ways of guiding policy and personnel as well as technical and economic proof and feasibility studies on intelligence and scientific research management and important economic and science research matters. They have published articles that have meaning and direction; they have proposed a series of new views, new ideas, and new proposals that have attracted the attention of the Central Committee and some provincial and municipal organs, and have drawn favorable reaction from within and without the country. They have done a large amount of work in researching and popularizing the basic theory of science. The Light Industry Research Institute of Tianjin has utilized scienology theory to improve it's scientific research management, which has enabled it to decrease it's scientific research period by half. For the past three years, they have appraised an average of 10 items a year, of which two to three have met or

appraised an average of 10 items a year, of which two to three have met or approached international standards. This year, in less then 6 months, they have already reviewed six achievements.

This afternoon, the council convened the meeting and elected Qian Sanqiang director, Yu Xueyuan, Qian Xuesen, Li Chang, Tong Dalin, Hu Yongchang, Huang Sui and others to be consultants.

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